A REVISION OF THE TUBEROUS-ROOTED SPECIES OF *TRIGLOCHIN* L. (JUNCAGINACEAE) IN AUSTRALIA

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ABSTRACT

Aston, Helen I. A revision of the tuberous-rooted species of *Triglochin* L. (Juncaginaceae) in Australia. **Muelleria 8(3): 331–364 (1995).** — All but one, *Triglochin dubium* R.Br., of the tuberous-rooted species of *Triglochin* L. are endemic to Australia. Floras of this century have commonly embraced all species within *T. procerum* R.Br., either without any distinction or as varieties or stated synonyms, although *T. dubium* and *T. pterocarpum* Fitzgerald have sometimes been maintained as distinct from *T. procerum*. In this revision, based chiefly on the morphology of vegetative features and of mature fruits and carpels, eight species are recognised, namely *T. alcockiae* Aston, *T. dubium* R.Br., *T. huegelii* (Endl.) Aston, *T. lineare* Endl., *T. microtuberosum* Aston, *T. multifructum* Aston, *T. procerum* R.Br. and *T. rheophilum* Aston. No infraspecific taxa are recognised but the variability remaining within the greatly reduced circumscription of *T. procerum* warrants further investigation. Lectotypes are designated for *T. lineare* Endl., *T. procerum* R.Br., *T. procerum* var. *eleutherocarpum* Benth., *T. pterocarpum* Fitzgerald, *Cycnogeton huegelii* Endl. and the generic name *Cycnogeton* Endl. A new combination, *T. huegelii* (Endl.) Aston (basionym *Cycnogeton huegelii* Endl.) is made. *T. procerum* var. *gracile* Mich. is redefined to exclude *T. lineare* Endl. from its circumscription, *T. procerum* var. *gracile pro parte*, excl. *T. lineare* being placed as a nomenclatural synonym under *T. dubium*. *T. procerum* var. *eleutherocarpum* Benth. is placed as a new taxonomic synonym under *T. huegelii* and *T. pterocarpum* Fitzgerald is upheld as a taxonomic synonym under *T. dubium*.

INTRODUCTION

All but one of the tuberous-rooted species of *Triglochin* L. are endemic to Australia where their combined distribution (Fig. 1) is widespread in aquatic habitats. The one exception, *T. dubium* R.Br., has its greatest distribution within Australia but also extends to New Guinea.

The eight species recognised here have been commonly embraced within the circumscription of *T. procerum* R.Br. and four of them were only recently described in a precursor paper (Aston 1993). This precursor should be used in conjunction with the current revision.

Amongst recent investigations of tuberous-rooted *Triglochin*, Robb & Ladiges (1981), working with Victorian populations, demonstrated links between chromosome ploidy levels and fruit morphology. The entities they distinguished are readily related to species included in the current paper (see under Chromosomes below). McDonell (1969), working with populations in an area of central-coastal New South Wales bounded by Kurnell, Camden, Richmond and Newcastle, distinguished four entities in which she linked growth-form (of leaves) with carpel number and fruit shape. Unfortunately no voucher collections were preserved to assist with the taxonomic interpretation of her results and I find that insufficient detail and the exclusion of some characters makes identification of her entities ("growth-forms") inconclusive. It is most likely that entity 1 = *T. procerum* (eastern variant), 2 = *T. microtuberosum*, 3 = *T. procerum* (excluding the eastern variant) and 4 = *T. rheophilum*. Keighery (1975) investigated breeding systems in species from south-western Western Australia, presumably *T. huegelii* and *T. lineare* although published as varieties of *T. procerum* [*sens. lat.*]. His experiments with covered and uncovered inflorescences produced equal seed set by self-pollinated and cross-pollinated plants. There was no fruit development or

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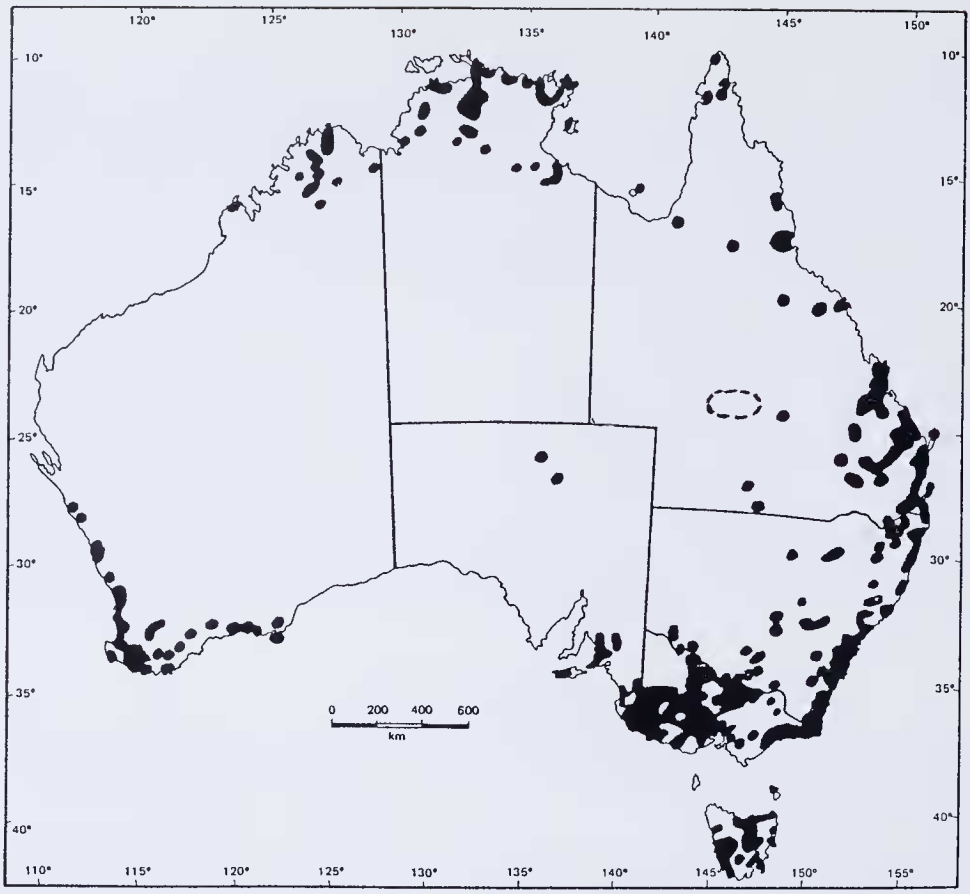

Fig. 1. Distribution of the tuberous-rooted species of *Triglochin* within Australia. The dashed ellipse represents an approximate locality.

seed set by six buds bagged after emasculation (all from the same species), indicating that the species was not apomictic. McDonell (1969) also found both self-fertility and cross-fertility of inflorescences in experiments with New South Wales plants. Rea (1992) and Rea & Ganf (in press) report the effects of water level changes on *T. procerum* (excluding the eastern variant) in Bool Lagoon, south-east South Australia. They emphasise the rapid response time to depth changes, the morphological plasticity of the species and the changes in biomass allocation between leaves and tubers with changing water levels.

The tuberous-rooted species form a natural grouping based on their thickened, woody, fibre-covered rhizomes and their conspicuous storage tubers terminal on the roots. These subterranean features are quite unlike those of other species currently placed in *Triglochin* and could possibly be used as a distinguishing character applicable at generic rank. If further studies within the family supported such a generic distinction then the name *Cycnogeton* Endl. should be reinstated. See 'Notes — Typification' under *T. huegelii* (Endl.) Aston.

MATERIALS AND METHODS

This revision is based upon the morphological examination of herbarium collections from all major Australian herbaria and upon extensive examination of plants in the field. Where necessary for nomenclatural reasons, additional type collections have

been received on loan from overseas herbaria. Unfortunately all Juncaginaceae at W, where Endlicher's types would be expected, was destroyed during the second world war (Riedl 1981).

Dried herbarium collections from the past have provided much data although many are often incomplete. The taxonomically important rhizomes and tubers are usually lacking, and the essential infructescences are also frequently absent. Mature fruits, which readily fall from the pedicels, have often rolled from sheets over the years unless originally placed in retaining packets.

I have not yet been able to conduct field observations on *Triglochin huegelii*, *T. lineare*, or the western variant of *T. procerum* found in South Australia and Tasmania. However, much information on all other taxa has been gained from extensive field work in Victoria and south-eastern New South Wales, from a brief period on the Dampier Peninsula, Western Australia, and from spasmodic sightings in southern Queensland. Measurement ranges, particularly for leaves, scapes and infructescences, were made in the field and complete plants obtained. Tubers, flowers, mature fruits, and leaf cross sections were preserved in 70% ethyl alcohol for later examination. Information on habit, variability within populations, and other relevant points cited in the species accounts were noted.

ASSESSMENT OF MORPHOLOGICAL CHARACTERS

All measurements and descriptions of both vegetative and reproductive parts are taken from plants bearing inflorescences or infructescences.

Rhizomes — Rhizomes are almost invariably broken when dug from the soil so that differences in lengths should be disregarded. Diameters given apply to the woody rhizome itself and exclude the fibrous coating. Diameters are generally greater in the species which inhabit deeper and more permanent waters, e.g. *T. multifructum* and *T. procerum*, and lesser in species of ephemerally indundated areas, e.g. *T. alcockiae*. Accordingly, although diameter differences between species appear to be correlated with the length of available growing time, there is probably also some genetic basis for them. With care, the rhizome diameter of mature plants may be of use in identification.

Roots and Tubers — These need to be considered in relation to each other. The tubers are storage organs only, not reproductive, changing in number and in mass with changing water depth (Rea & Ganf, 1994; Rea 1992). They vary from the small, near-globular ones about 5 mm long on short roots characteristic of *T. microtuberosum* to the large, long-cylindrical ones to 145 mm long on long roots characteristic of *T. procerum* (Fig. 2). Ratios for tuber length:tuber diameter and for root length:tuber length, as well as actual measurements and descriptions of tuber shapes are given in the text. Although there is overlap between species, tuber size and shape appears to be genetically controlled within certain ranges for each species and distinguishes some from others. Root and tuber combination is diagnostic for *T. microtuberosum*.

Tubers shrink upon drying, hence measurements have been made on fresh and/or spirit material for all taxa seen in the field. Where measurement from dried material has been necessary, subjective allowance has been made for shrinkage.

Leaves — Slender species such as *T. alcockiae* and *T. lineare* generally have shorter and narrower leaves than others which are more robust but there is considerable overlap in leaf length and width between species. Sheath length in relation to leaf length is of no taxonomic value.

The cross-sectional shape of the lower portion of the leaf and the comparative width of the basal sheaths are important in distinguishing some species. These characters have been expressed by referring to transverse sections of leaves cut at a level approximately 3 cm below the top of the sheath (Fig.3). In such a section, the leaf varies from almost linear or very thinly plano-convex as in *T. rheophilum* to sub-cylindrical or near-cylindrical as in *T. microtuberosum*, the eastern variant of *T. procerum*, and the north-western plants of *T. dubium*. These sections also show the sheath width in relation to the width of the central portion of the leaf, e.g. each sheath extending only to

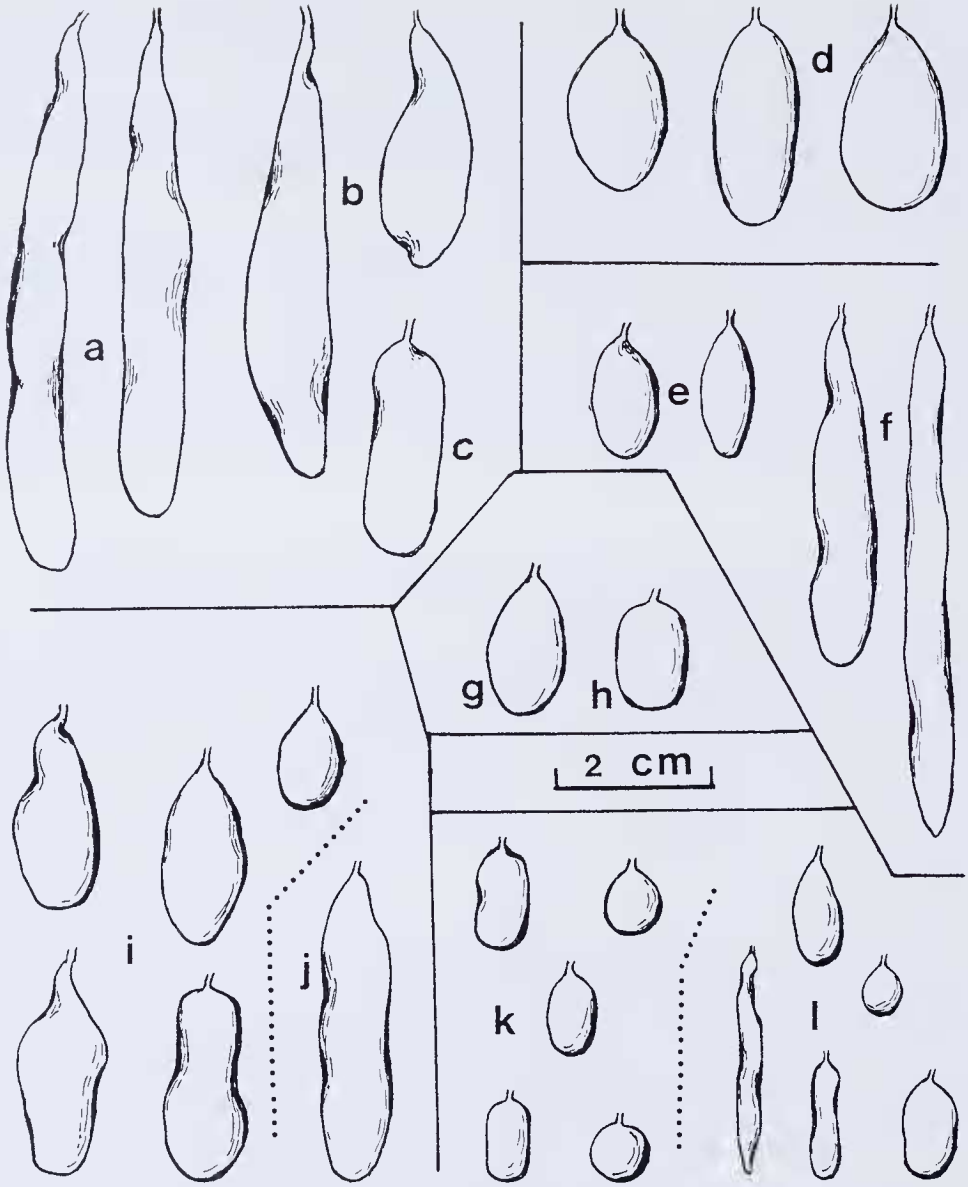

Fig. 2. Tubers. a-c *Triglochin procerum*. d — *T. dubium*. e-f — *T. rheophilum*. g-h — *T. alcockiae*. i-j — *T. multifructum*. k-l — *T. microtuberosum*, including unusually elongated tuber from the Morpeth population (l). (All drawn from *Aston numbers* (MEL, spirit): a — *2840*; b — *2780*; c — *2832*; d — *2745*; e — *2838*; f — *2824*; g — *2722*; h — *2709*; i — *2797*; j — *2781*; k — *2816*; l — *2792*)

a quarter of the width across the central portion of the leaf in *T. rheophilum*, but the two sheaths of *T. microtuberosum* touching to overlapping across the centre. Ratios and percentages are used in the species descriptions in an attempt to quantify leaf cross-sectional shape and the proportional values of sheath width.

The submerged foliage of *T. rheophilum* is distinctive. With other species, foliage is emergent but the emerged portions vary from floating to erect, sometimes within the same species. Thicker, more turgid leaves (e.g. eastern variant of *T. procerum*) are usually erect, or erect with outcurved extremities, whereas thinner, flaccid leaves (e.g.

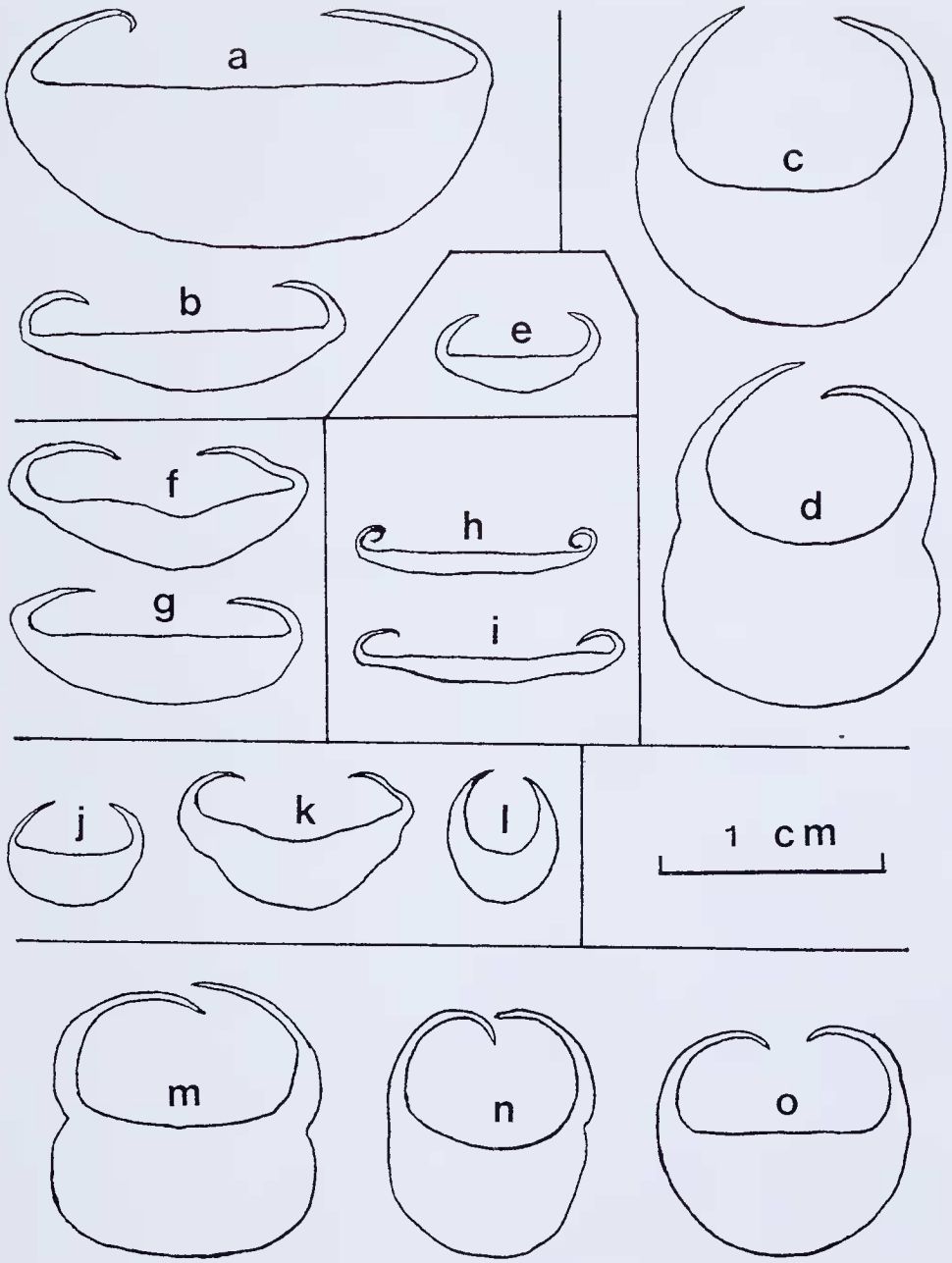

Fig. 3. Leaves, outline of T.S. about 3 cm below the sheath summit. a-b — *Triglochin procerum*, excluding eastern variant. e-d - *T. procerum*, eastern variant. e — *T. alcockiae*. f-g — *T. multifructum*. h-i — *T. rheophilum*. j-l — *T. dubium*, from south-eastern Australia (j-k) and the Kimberley (l). m-o — *T. microtuberosum*. (All drawn from *Aston numbers* (MEL, spirit): a — *2832*; b — *2690*; c — *2825*; d — *2836*; e — *2705*; f — *2781*; g — *2779*; h — *2824*; i — *2842*; j — *2804*; k — *2787*; l — *2696*; m — *2685*; n — *2792*; o — *2816*)

T. alcockiae) are usually floating. Differences in growth-form are largely specifically or infraspecifically linked and therefore appear to be largely genetically controlled. However, factors such as age and environmental conditions are influential in modifying leaves. Rea (1992), experimenting with *T. procerum* at Bool Lagoon, South Australia, found that new leaves produced with changing water levels adjust their length and width according to depth, increasing both measurements as water deepens. At constant water levels, leaves were erect when mature and later arched over so that the tips touched the water surface. Seedling leaves were narrow, thin and floating.

Stems — Dimensions vary from the more slender to the most robust species but are not specifically distinct. Their morphological characters are taxonomically insignificant.

Flowers — My initial examination of floral parts from field observations and from spirit-collected material failed to show significant diversity between species, except for the number of carpels present and perhaps also for the size and shape of stigmatic hairs. Accordingly I have virtually omitted floral parts from this study, but whenever possible I have continued to collect them as an integral part of all spirit collections made. Carpel number for each species has always been ascertained from flowers as some species commonly abort carpel development, causing fruits to be unreliable indicators of the number of carpels initially present in each flower.

A scanning electron microscope study of stigmas could possibly provide useful taxonomic information. B.L. Rye, in Marchant *et al.* (1987; 2: 722), gives differences in the length of anthers between *T. huegelii* (as *T. procerum* var. *eleutherocarpa*) and *T. lineare* (as *T. procerum* var. *procerum*) but I have not seen either fresh or spirit material of these species.

Infructescences — Infructescence dimensions are never diagnostic but are helpful in distinguishing some species. For example, *T. alcockiae* and *T. multifructum* have infructescences of similar diameter but, except in a few extremes, of dissimilar length. The shorter, and therefore comparatively wider, infructescences of the former species are almost always distinguishable from the long slender infructescences of the latter on dimensions alone. When dimensions are coupled with the size, shape, spacing and number of mature fruits, the infructescences are unmistakeable.

Infructescences with mature fruits along their whole lengths have been used for measurements. Diameters were measured across the widest portion of each infructescence from fruit apex to fruit apex but excluding any portions of fruits or carpels which protruded excessively beyond the general outline of an infructescence. As mature fruits readily fall, numbers were obtained for each infructescence by counting the pedicels found on each rachis. To give quantitative expression to the density of fruits, the number of fruits counted was divided by the rachis length for each infructescence. For species where fruit density is very much reduced along the basal portion of the infructescence this portion was excluded when calculating the density.

The rachis and/or pedicels of most species are usually cream-green or green but sometimes may be tinged or deeply coloured in maroon or cyclamen shades. However, *T. multifructum* characteristically has the rachis and pedicels coloured maroon-cyclamen, often deeply so. Pedicel length is generally similar for all species but is sometimes much longer and more slender in *T. rheophilum*. At such times it is an aid to identification.

Fruits and Mature Carpels — The shape, size, number and freedom or attachment of carpels in the mature fruit, and hence the characteristics of the whole fruit, are of major diagnostic significance. Descriptions of these parts are therefore detailed.

Mature carpels are described as spiralled or twisted when they exhibit lateral rotation and straight when they do not. Spiralled carpels usually produce fruits which also appear twisted. Each carpel may possess three longitudinal ridges, one dorsal and two lateral or shoulder ridges; the surface between a lateral ridge and the ventral edge of a carpel is termed a lateral face. Ridges may be obscure to well-pronounced, the variation being expressed quantitatively from measurements made on transverse sections cut approximately midway along carpel lengths (Fig. 4). The carpels of a fruit may be free, as in *T. dubium* and *T. huegelii*, or variably connate along their ventral edges as in

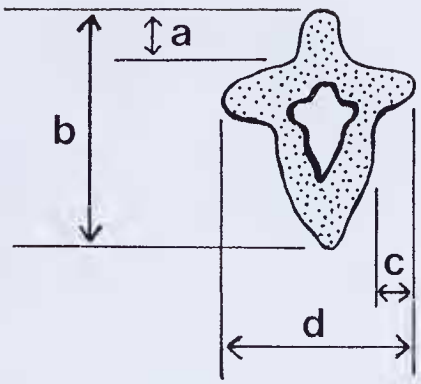

Fig. 4. Mature carpel in transverse section, diagrammatic. a = length of dorsal ridge. b = carpel depth. c = length of lateral ridge. d = carpel width.

other species. The length for which a carpel is connate has been termed the attachment length of the carpel (e.g. Fig. 5, b & d) and this is expressed as a percentage of the total carpel length. Total carpel length includes the stylar beak as this is frequently not demarcated from the remainder of the carpel.

CHROMOSOMES

Robb & Ladiges (1981) reported a simple polyploid series, $2n = 16, 32, 64$, in their chromosome counts on collections of the *Triglochin procerum* aggregate from Victoria. Their counts correspond to $2n = 16$ for *Triglochin multifructum*, 32 for *T. microtuberosum* and 64 for *T. rheophilum* and *T. procerum* (excluding the eastern variant). With *T. procerum* three of the eight collections which they examined produced counts of $2n = 62$ or 63, rather than 64, an aberrance which may be due to the difficulty of counting or may relate to the great morphological variation found within this entity.

The collections used by Robb & Ladiges did not include what is described here as an eastern variant of *T. procerum*. However, *Constable 5969* and *Briggs NSW 80707* are this variant and both have in the past (undated) been annotated with chromosome counts by B.G.Briggs. Her count for *Constable 5969* is $2n =$ c. 60–64, and for *Briggs NSW 80707* is $2n = 46–48$. This latter count is the first report of a hexaploid within the polyploid series. The possession of both hexaploid and octoploid chromosome numbers by the eastern variant of *T. procerum* may be related to its very variable fruit morphology. See 'Morphological Variation' and 'Field Observations' under *T. procerum*.

The count of $2n = 32$ ascribed to *T. procerum* by Briggs (1966) for the collection NSW 65826 [= *Constable 4946*] actually refers to a collection of *T. microtuberosum*. This is consistent with the findings of Robb & Ladiges.

The chromosome numbers of other species treated in this revision are unknown.

USES

Tubers of at least *T. dubium* and *T. procerum* are known to have been a staple food of aboriginal people in northern and south-eastern Australia respectively (see *T. dubium*, field observations, and Gott 1982, 1993).

T. dubium and *T. microtuberosum* have been found heavily grazed by cattle and *T. multifructum* similarly grazed by sheep where stock had gained access to populations following falls in water levels (pers. obs.).

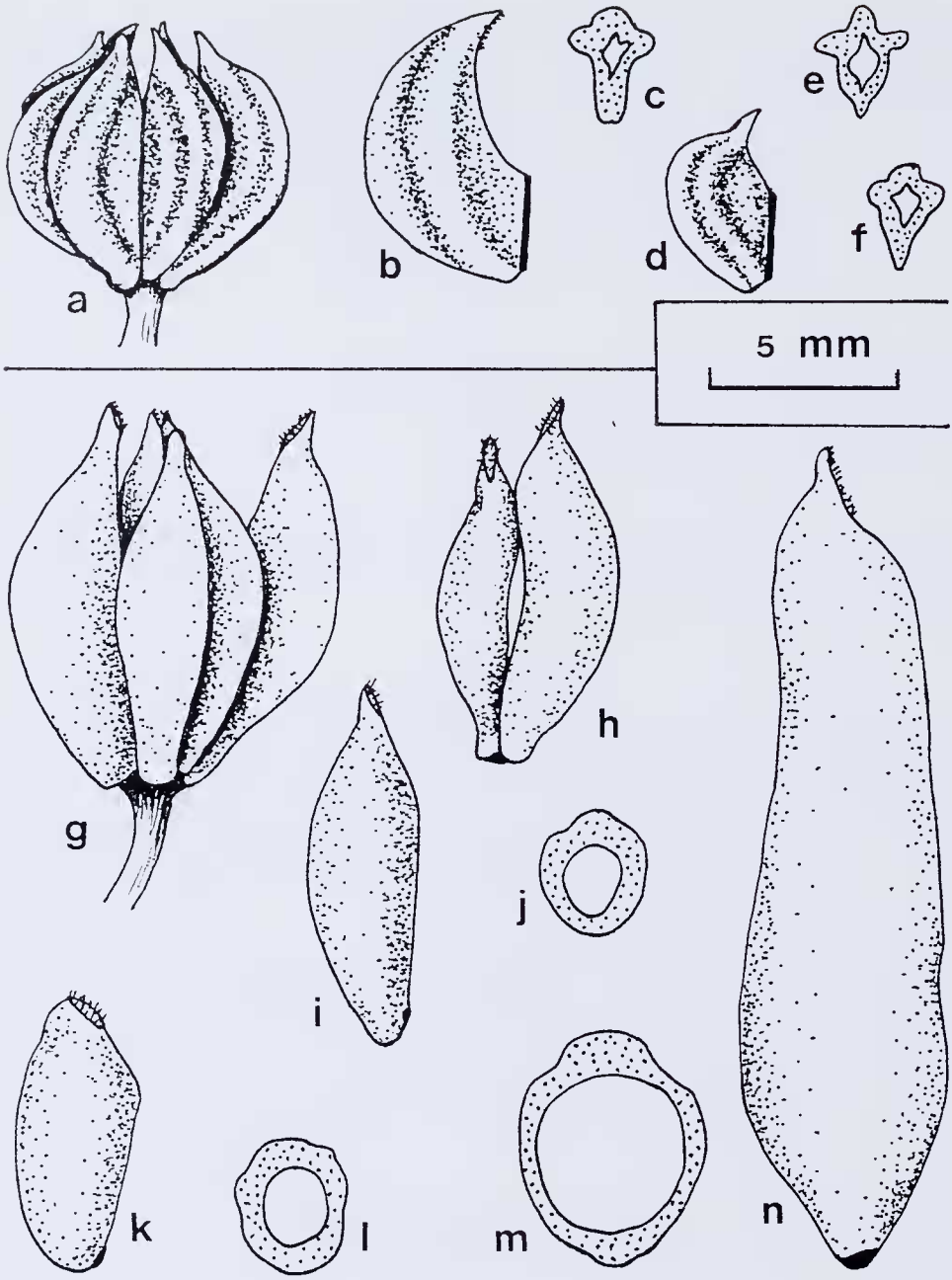

Fig. 5. Fruits and mature carpels. Attachment length shown by a thickened line on carpels in lateral view. a-f — *Triglochin alcockiae*, from western Victoria (a-c) and from Dandenong, Victoria (d-f). a — fruit, lateral view. b-c — carpel, lateral view and T.S. d — carpel, lateral view. e-f — carpels in T.S. g-n - *Triglochin dubium*, from Victoria (g-l) and from Dampier Peninsula, Western Australia (m-n). g-h — fruits with 5 and 2 mature carpels, lateral view. i-j — carpel, lateral view and T.S. k-l — carpel, lateral view and T.S. m-n — carpel, T.S. and lateral view. (a-c — from *Aston 2722*. d-f — from *Aston 2852*. g-j — from *Aston 2778*. k-l — from *Aston 2804*. m-n — from *Aston 2696*)

TAXONOMY

Triglochin L., *Sp. Pl.* 338 (1753). LECTOTYPE: *T. palustre* L., *fide* Britton, *N. American Fl.* 17: 41 (1909).

Description for tuberous-rooted species only — *Perennial, aquatic herbs. Rhizomes* thick, woody, densely covered with fibres formed from the bases of the vascular bundles of otherwise decayed leaves, bearing simple roots which frequently terminate in storage tubers; rhizomes often with several short adjacent branches forming a clustered rootstock. *Leaves* radical, arising in tufts from the rhizome, more or less linear, flattened distally, becoming thickened and spongy toward the base in most species, sometimes subcylindrical throughout, sheathed proximally, emergent in most species with the emergent portions erect to floating; sheath open, never ligulate or auriculate. *Stems* simple, axillary within the leaf tufts, erect to reclining, elliptic depressed-obovate or circular in cross section but irregularly so. *Inflorescence* a terminal raceme, ebracteate, few- to many-flowered, usually dense and spike-like. *Pedicels* shorter than the flowers or fruits, persistent, spreading to upcurved in fruit. *Flowers* small, bisexual, trimerous, often near-sessile, protogynous. *Perianth* segments 6, in 2 similar, alternate whorls, deciduous, concave, each segment incurved over an anther. *Stamens* 6, each inserted on the base of a perianth segment and semi-enveloped by it, the segment and anther falling together after anthesis; anther near-sessile, as broad as or broader than long, 2-locular, longitudinally and retrorsely dehiscent. *Gynoecium* superior, of (2 or)3–6(–8) free to united carpels; central carpophore absent; ovules 1 per carpel, anatropous. *Style* adaxially terminal, short and thick, appearing as a tapered continuation of the ovary, erect to outcurved in flower, often forming a prominent beak in fruit. *Stigma* sessile, elongated, adaxially lateral along the apical portion of the style, papillate to finely hairy. *Fruiting carpels* follicle-like but indehiscent, 1-seeded, free to closely adpressed, forming distinctively shaped fruits, all separating and falling at maturity. *Seed* narrowly elliptic, basal, erect.

KEY TO THE TUBEROUS-ROOTED SPECIES OF TRIGLOCHIN L.

1. Tubers small, mostly 4.5–13 mm long, often near-globular, clustered closely beneath the rhizome; fruits 7–9.6 mm long, very broadly obovoid with base contracted and stalk-like; mature carpels (5 or)6, ventrally attached; dorsal surface of mature carpel ± flat, shallowly indented, or shallowly rounded, never keeled or ridged ..... **T. microtuberosum**

1. Tubers mostly larger, ellipsoid or obloid to narrowly so or long-cylindrical, distanced from the rhizome; fruits not as above; mature carpels keeled or ridged (except in *T. dubium*) ..... 2.

2. Mature carpels free ..... 3.

2. Mature carpels ventrally attached along at least one-fifth of their length (length includes the stylar beak) ..... 4.

3. Mature carpels straight, not incurved, smooth, ± circular in cross-section, erect to semi-outspread in fruit ..... **T. dubium**

3. Mature carpels straight or somewhat twisted, strongly incurved, dorsally and laterally ridged, ± obtrullate in cross-section, erect or somewhat twisted and usually overlapping in fruit because of their curvature ..... **T. huegelii**

4. Leaves linear, usually submerged and isolateral, thin-textured; leaf-sheaths narrow, mostly tightly inrolled with the width of each usually less than one quarter of the leaf width (as seen in T.S. c. 3 cm below the sheath summit); plant of clear-flowing streams ..... **T. rheophilum**

4. Leaves linear-tapered, emergent, dorsiventral, spongy in texture; leaf-sheaths broader, gradually incurved, the width of each usually one third or more of the leaf width, both sheaths often overlapping ..... 5.

5. Fruits small, usually 3–5 mm long and globular in outline or to 8.5 mm long and more ellipsoid, c. 230–1000 per infructescence, tightly touching, 14–27 on each centimetre of

rachis length; mature carpels each with a prominent narrowly obtuse dorsal keel and two prominent lateral (shoulder) keels ..... **T. multifructum**
5. Fruits not as above, c. 1–320 per infructescence, mostly loosely or not touching, 2.6–11 (or -18 on western variant of *T. procerum*) on each centimetre of rachis length; mature carpels each with variably prominent to near-absent dorsal and lateral keels .....6.

6. Tubers usually elongated, narrow-ellipsoid to cylindrical, less frequently ellipsoid to obovoid, 20–145 mm long, length 2.5–20 times diam.; plants usually robust, sometimes slender, with leaves 5–41 mm wide, scape 4–23 mm diam., infructescence 17–42 mm diam.; fruits very variable ..... **T. procerum**
6. Tubers ± ellipsoid or globular to obovoid, 8–30 mm long, length 1–3.7 times diam.; plants slender, with leaves 1–12 mm wide, scape 1–6 mm diam., infructescence 7–19 mm diam. .....7.

7. Fruits globular to depressed-globular in outline, usually broader than long; mature carpels characteristically ventrally attached along only the lower 20%-39% of the carpel length (length includes the stylar beak), but attached to 59% in the more easterly Victorian populations ..... **T. alcockiae**
7. Fruits ellipsoid to ellipsoid-obloid in outline, longer than broad; mature carpels characteristically ventrally attached along 46%-72% of the carpel length, sometimes as little as 27% ..... **T. lineare**

Triglochin alcockiae Aston, *Muelleria* 8: 85 (1993). TYPE: "Victoria, c. 38 km (straight line) south-west of Horsham. Swamp at north end of Toolondo Reservoir. 36°59′S, 141°56′E. .... 9 Nov. 1988, H.I. Aston 2705". HOLOTYPE: MEL 705957. ISOTYPES: AD, BRI, CANB, CBG, HO, K, MEL 705956 & 705962 & 705963 & spirit material, NSW, PERTH.

Original Description — see also under Notes below — *Rhizomes* vertical, 1.7–7 cm long × 7–10 mm diam., bearing short fine soft fibres to 2 cm long, rarely to 11 cm. *Tubers* ellipsoid, obloid or globular to oblanceolate or obovate, 8–20(–28) mm long × 5–12 mm diam. (length 1.0–3.0 times the diam.), terminating roots 5–35 mm long; each root 0.3–2.3 times as long as its tuber. *Leaves* (6–)26–91 cm long × (1–) 2–8 mm wide, dorsiventral, medium-green and glossy above, paler beneath, bending below the water surface, the emerged portions floating and maintaining contact with the water along their whole length (or sometimes held semi-erect by surrounding herbage), ± linear, flat to slightly plano-convex in T.S., shortly tapered, obtuse, moderately thickened and spongy toward the base, sheathed over the lower 16%–38% of the leaf length. *T.S. leaf about 3 cm below the sheath summit*: narrowly plano- to concavo-convex, width 3.8–4.3 times the thickness; each side of sheath 2.1–2.6 mm wide, equal c. 34%–45% of the leaf width. *Stems* in fruit 28–81 cm long (including the infructescence) × 1.3–5.9 mm diam. *Rachis* 1.0–2.6 mm diam. at base, gradually tapered upwards; rachis and pedicels pale cream-green or the rachis (occasionally also the pedicels) pale to deep maroon-red. *Infructescence* (0.6–)2–13.5 cm long (= 5%–28% of the total stem length) × 11–19 mm diam. *Pedicels* often upcurved, 1.2–3.5 mm long. *Fruits* loosely touching to shortly spaced, (1–)8–67 per infructescence, 3–8 per 1 cm of rachis length, globular to depressed globular in outline, usually broader than long, 5.6–8.7 mm long × 6.6–9.9 mm diam. *Carpels* (5 or)6, in fruit straight and erect or the upper portions partly spiralled around each other and then giving a semi-twisted appearance to the fruit, all maturing or 1 or 2 (occasionally to 5) aborted, 5.6–8.5 mm long × 1.3–3.0 mm wide × 2.3–4.1 mm deep; ventral edges attached only over the lower portions; attachment length = 20%–39% of the carpel length; lateral faces ± flat to slightly concave or convex, mostly not adpressed; dorsal ridge broad-rounded, 10%–22% of carpel depth; shoulder ridges rounded, 17%–26% of carpel width. (Figs 2g-h, 3e, 5a-f)

SELECTED ADDITIONAL SPECIMENS EXAMINED (not cited in Aston, 1993; total additional = 5)

Victoria — Greens Road, c. 3.5 km SE of Dandenong railway station, 30 Nov. 1992, *Aston 2852* (AD, CANB, K, MEL, NSW); Lal Lal, c. 250 m NW of the railway station, 4 Dec. 1992, *Aston 2855* (AD, K, MEL, NSW).

DISTRIBUTION (Fig. 6)

South Australia (Kangaroo Island, South Lofty Ranges, and south-east region), Victoria (typically south-western, extending east to about Dandenong), and Tasmania except in the north-west.

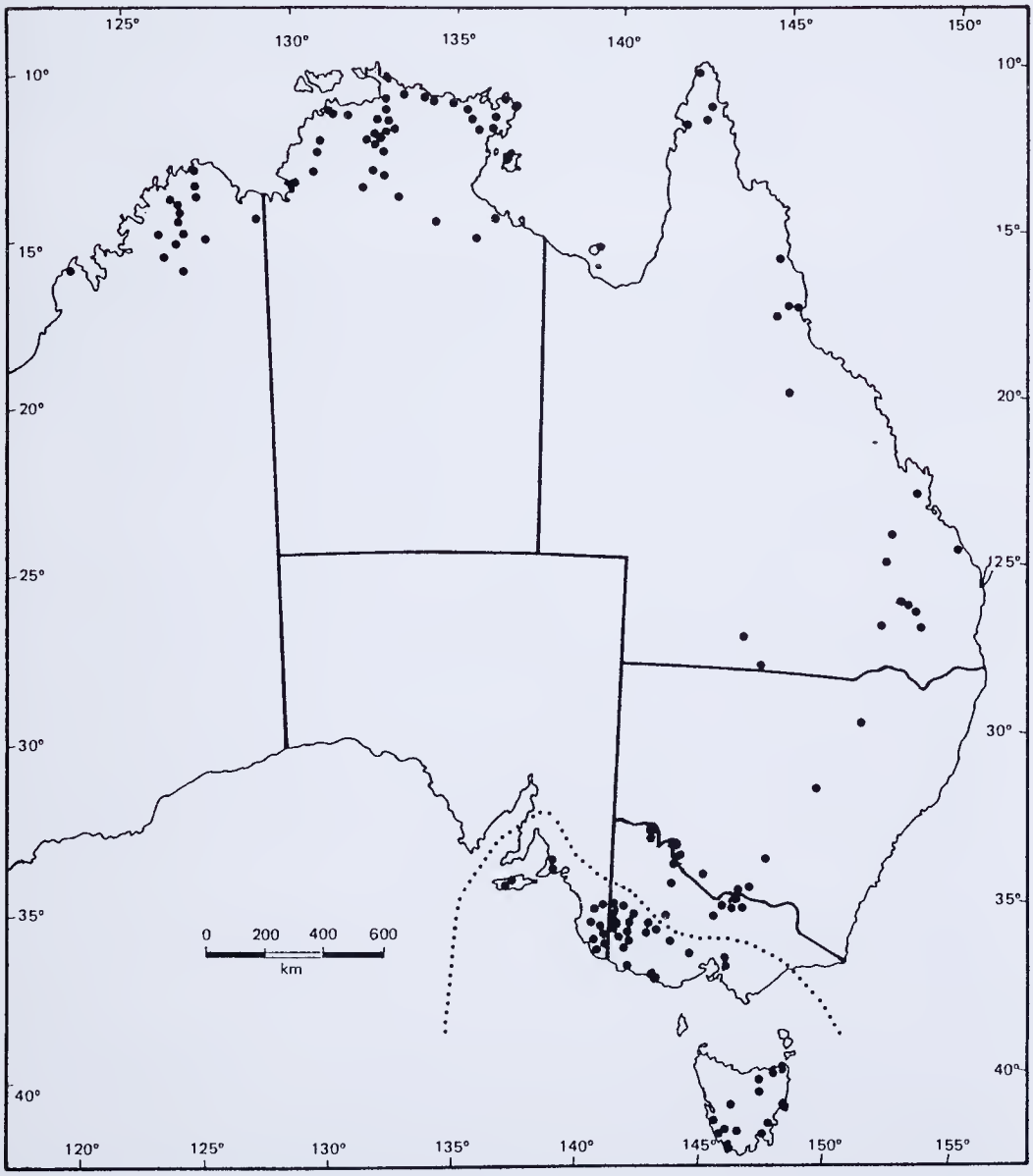

Fig. 6. Distribution of *Triglochin alcockiae* (below dotted line), and the Australian distribution of *T. dubium* (above dotted line).

NOTES

See Aston (1993) for fuller information on this species.

Recent discoveries have expanded the known Victorian range of *T. alcockiae* beyond that given in Aston (1993), extending it eastwards to the vicinity of Dandenong. Material from these eastern populations has extended the range of some measurements given in the original description, but generally only slightly so. In other respects, except for the variations which follow, plants of the more easterly populations fit the original description given above.

The major variation is in the attachment length of the mature carpels. This length is usually much greater than that previously reported, being (12.5%–)39%–49%(–59%) of the carpel length compared with 20%–39% originally reported for more westerly populations. Because of this feature, most mature fruits have straight, non-spiralled, close-held carpels, so that the fruit breadth more or less equals the length. Fruits also tend to be somewhat smaller (4.7–7.5 mm long compared with 5.6–8.7 mm in other populations; 4.9–7.4 mm diam. cf. 6.6–9.9 mm). Dorsal ridges vary from broad-rounded as originally described to narrowly obtuse and quite pronounced, namely to 32% of the carpel depth, compared with 10%–22% measured from other populations.

DIAGNOSIS

A comparatively small and slender species with distinctive fruits and partially distinctive tubers. Mature fruits are comparatively few, 1–67 per infructescence, to 8.7 mm long and 9.9 mm diam., usually somewhat broader than long (but see Notes above), globular to depressed-globular in outline with rounded to narrowly obtuse dorsal ridges. Fruiting carpels are ventrally attached only over the lower 20%–39% of the carpel length in most populations (sometimes to 59%; see Notes above). The free upper portions of the carpels may be partially spiralled around each other. Of the (5 or)6 carpels in the developing fruit all mature or frequently 1 or 2, sometimes more, may abort.

Tubers are distinctively smaller and plumper than those of the sympatric *T. procerum* but can resemble those of some of the allopatric species of *Triglochin*.

Triglochin dubium R.Br., *Prodr. Fl. Nov. Hollandiae* 343 (1810). — *T. procerum* var. *dubium* (R.Br.) Benth., *Fl. Austr.* 7: 169 (1878). — *T. procerum* var. *gracile* Micheli in A.DC & C.DC., *Monogr. phan.* 3: 108 (1881) *pro parte*, excl. *T. lineare* Endl., *nom. illeg., nom. superfl.*, **syn. nov.** TYPE: "(T.) v.v.", R. Brown. HOLOTYPE: Bentham, *op. cit.*, stated "I find no specimen in Brown's herbarium..." [i.e. at BM]. Currently, types have not been located at BM, E, G, G-DC, K, M, P, UPS, or W. See Notes below.

Triglochin pterocarpum Fitzgerald, *J. Proc. Roy. Soc. W. Australia* 3: 110 (1918). TYPE: "Isdell and Charnley Rivers (W.V.F.)." [= Kimberleys, W. Australia]. **LECTOTYPE (here designated)**: "Isdell River, 4 miles below Mt Barnett homestead, North Western Australia, W.V. Fitzgerald 1037, June 1905" (NSW 6965)!. ISOLECTOTYPE: "Isdell River 4 miles below Mt Barnett homestead, W.V. Fitzgerald 1037, June 1905" (PERTH 00993018)! REMAINING SYNTYPE: "Charnley River Lat. 16° 17′, W.V.Fitzgerald 1414, Aug 1905" (PERTH 00993026)! Types not located at B, BM, E, K, PRE. See Notes below.

Triglochin procerum 'dubium', Aston *in litt.*

Description from extra-tropical material — *Rhizomes* semi-horizontal to vertical, 2–8 cm long × 5–12 mm diam., bearing fine soft fibres 2–7 cm long. *Tubers* near-globular to ellipsoid to broad-oblong to broad-obovoid, 11–38 mm long × 7–14 mm diam. (length (1–)1.2–3.8 times the diam.), terminating roots (8–)20–80(–106) mm long; each root 1–4(–5.3) times as long as its tuber. *Leaves* 31–75 cm long × 3.5–15 mm wide at widest part of the blade, dorsiventral, deep glossy green above, mid yellowish-green beneath, the emerged portions semi-erect or with the extremities recurved and sometimes floating on the water surface, sometimes the emerged portions fully floating without losing contact with the water, ± linear but gradually narrowed above the sheath then gradually widening and finally tapered distally, acute, thickened and spongy toward the base, sheathed over the lower 21–34% of the leaf length. *T.S. leaf about 3 cm below the sheath*

summit: narrowly plano- to concavo-convex, width 2.5–3.8 times the thickness; each side of sheath 2.1–4.3 mm wide, equal c. 25%-38% of the leaf width. *Stems* in fruit (27–)55–94 cm long (including the infructescence) × 2–8 mm diameter. *Rachis* 1–3(–4.5) mm diam. at base, gradually tapered upwards; rachis and pedicels light to medium green, the pedicels sometimes tinged maroon-red, rarely both rachis and pedicels maroon-cyclamen. *Infructescence* (4–)8–27 cm long (= 14%–38% of the total stem length) × 13–25 mm diameter. *Pedicels* 1.3–3.5(–5) mm long, slender, upcurved. *Fruits* loosely to not touching, mostly directed upwards at about 45°–60° angle, (15–)39–250 per rachis, 5–9 per 1 cm of rachis length, variable in outline but usually ± obtriangular when three or more carpels mature, 8.3–10.5 mm long × 5.5–8.8 mm diameter. *Carpels* (2 or)3(–6), ± straight, lanceoloid ellipsoid or obloid, erect to semi-outspread in fruit, 1–6 maturing, often some aborted, 7.4–10.5 mm long × 2.2–3 mm wide × 2.75–3.7 mm deep; carpels free or very shortly attached at the base; attachment length = 0%–3%(–5%), very rarely to 13.5%; lateral faces rounded, not adpressed; dorsal ridge absent to inconspicuous, broadly rounded (0%–17% of carpel depth); shoulder ridges absent, the whole carpel ± circular in cross-section. (Figs 2d, 3j-k, 5g-l)

Description from tropical material — As for extra-tropical description except for comparisons and additions given here. See also Notes — Geographical Variation below.

Tubers sometimes smaller, 8–21 mm long × 4–10 mm diameter. *Leaves* narrow, <1–6 mm wide, shaped as above or terete to semi-terete or almost filamentous. *Stems* tending narrower, 1–4 mm diameter. *Infructescence* tending longer, 11–38 cm long. *Fruits* more spaced, 2.6–4 per 1 cm of rachis length; for size see carpels. *Carpels* mostly much larger and more narrowly lanceoloid, the largest 20.2–21.1 mm long × 3.3–3.7 mm wide × 4.15–4.45 mm deep when mature, some apparently maturing when only 11–12 mm long. (Figs 3l, 5m-n)

Selected Specimens Examined (total examined = 134)

Western Australia — Bobby Creek, 11 km ENE of Beagle Bay township, 10 Apr. 1988, *Aston 2699* (DNA, MEL, NSW, PERTH); King Edward River, old CRA campsite, 1 km S of ford on track to abandoned Mitchell River homestead, 5 Jun. 1987, *Edinger 259* (BRI, MEL, PERTH); 110 km NW from Mt Elizabeth Station on track to Bachsten Creek, 30 Jun. 1987, *Molyneux & Forrester s.n.* (MEL); 5 km SSE of Kununurra, 10 Mar. 1978, *Paijmans 2304* (CANB).

Northern Territory — c. 33 km E of Goodparla Station, 26 Feb. 1973, *Adams & Lazarides 3108* (CANB, DNA); c. 37 km SSE of Jabiru, 30 Mar. 1981, *Craven 6640* (CANB, DNA, MEL); East Alligator River, 16 Feb. 1973, *Dunlop 3274* (CANB, DNA); 45 km SE of Ramingining, Arnhem Land, 18 Jun. 1989, *Dunlop 8488* (DNA); Warlock Ponds, 1 Apr. 1981, *Henshall 3730* (CANB, MEL); 12 km SW of Twin Falls, 25 May 1980, *Lazarides 8988* (BRI, CANB, MEL).

Queensland — Dawson Highway, c. 9 km WSW of Moura, 7 Sept. 1983, *Aston 2496* (BRI, MEL); Coconut Creek, c. 32 km S of Weipa, 10 Dec. 1981, *Clarkson 4180B* (BRI, CANB, MEL, NSW); Jardine River, at the road ford, 4 Sep. 1985, *Clarkson 6263* (BRI, MEL); Theodore road, c. 18 km N of Taroom, 19 May 1981, *Jacobs 4124* (NSW); Paroo River crossing W of Eulo, on road to Thargomindah, 27 Mar. 1976, *Purdie & Boyland 272* (BRI); Miara, c. 30 km NW of Bundaberg, 21 Apr. 1977, *Sharpe 2243* (BRI).

New South Wales — Bingera Creek, c. 7 km N of Tooleybuc, Victoria, 16 Dec. 1988, *Aston 2732* (MEL, NSW); Wangamong Creek, at crossing of the Berrigan to Oaklands road, 12 Nov. 1989, *Aston 2787* (MEL, NSW); 36 miles SW of Dubbo on Peak Hill road, 28 Nov. 1969, *Coveny 2520* (MEL); Jimaringle, 40 km NE of Barham, 10 Dec. 1971, *Trounce s.n. NSW228856* (NSW).

Victoria — Wimmera Highway, c. 16.5 km W of St Arnaud, 19 Dec. 1988, *Aston 2745* (AD, BRI, CANB, MEL); Lalbert Creek, at crossing of the Lalbert to Culgoa road, 5 Nov. 1989, *Aston 2778* (BRI, MEL); c. 6.5 km ESE of Nathalia, 5 Jan. 1990, *Aston 2805* (MEL, NSW); North entrance to Wallenjoe Swamp Game Reserve, 5 Jan. 1990, *Aston 2807* (MEL); Kings Billabong, 7 km SE of Mildura, 5 Dec. 1981, *Browne 69* (MEL).

Distribution (Fig. 6)

In Australia, occurs from the Kimberley in Western Australia across northern Northern Territory to Cape York Peninsula and eastern coastal Queensland, extending inland in southern Queensland, New South Wales (central and south-western slopes; south-west plains), and Victoria (central-northern and Murray River areas, south to about St Arnaud and west to about Mildura).

Also occurs in New Guinea (Steenis 1949; Leach & Osborne 1985).

HABITAT

In Victoria and New South Wales *T. dubium* occurs in shallow still ephemeral fresh water to 50 cm deep, usually in swamps, creeklets and floodplains and on surrounding saturated soils left by receding waters; also reported amongst dense *Typha* in a roadside ditch and in flooded rice crops. It is typically in sites dominated or edged by *Eucalyptus camaldulensis* (River Red Gum) or by *E. largiflorens* (Black Box) and *Muehlenbeckia florulenta* (Lignum), in semi-natural to grazed pasture settings, on sticky grey clay, sandy-clay, or loamy clay, overlain with shallow silt or sand. Associated species include *Azolla* spp., *Damasonium minus*, *Ludwigia peploides*, *Marsilea drummondii*, *Myriophyllum* spp., *Nymphoides crenata*, *Ottelia ovalifolia*, *Potamogeton tricarinatus*, *Utricularia australis*, sedges such as *Cyperus difformis* and *Eleocharis acuta*, and herbaceous grassland weeds.

In Western Australia and the Northern Territory *T. dubium* occurs also in saturated soils or still shallow water of ephemeral swamps and floodplains but also is found commonly in still pools (to 2 m deep) or slowly to strongly flowing fresh water of seasonal or perennial streams; also reported in freshwater seepage. It grows on sand, sandy-loam, dark mud, or heavy grey and black clay soils (sometimes strongly humic) or amongst sand gravel and rocks on streambeds. Sites include *Timonius timon/Melaleuca viridiflora/Pandanus* overstorey, *M. leucadendron/Barringtonia acutangula* woodland and "tall riparian forest". Associated species reported are *Pseudoraphis spinescens*, *Xyris* and *Utricularia*.

Queensland plants occur in varied habitats and on varied soils as do those of Western Australia and the Northern Territory. Sites include *Eucalyptus tetrodonta* open forest, *Casuarina cristata* ssp. *cristata* woodland, *Melaleuca* swampland, cleared Brigalow scrub, sedge/grass swampland and *Nymphaea gigantea* waterhole/claypan.

Altitude c. 50–170 m in Victoria and southern New South Wales, with one record (*Coveny 2520*) of 300 ± 40 m from south-west of Dubbo in the latter State. The only four altitude records available for other States range from 8–200 m.

In Victoria and New South Wales, flowers recorded (Oct. or)November to February and fruits (Oct. or)November to March. In Western Australia and the Northern Territory, flowers and fruits recorded every month except September. Queensland records spaced, but apparently flowers and fruits in all months.

NOTES

Typification of T. dubium — Robert Brown described *T. dubium* from material he collected at coastal and island sites in area "(T.)". This area embraces two regions, one approximately between Bowen and Gladstone, eastern Queensland, and the other around the Gulf of Carpentaria, from Prince of Wales Island, Cape York, Queensland, to Arnhem Bay, Arnhem Land, Northern Territory (Stearn 1962). The exact type locality is not known and apparently Brown's descriptive manuscripts at the British Museum (BM) do not include his account of this taxon (Burbidge 1955). Although Brown's published description of *T. dubium* is brief, it leaves no doubt that his name applies to the taxon circumscribed here. Without having undertaken extensive field work in northern and north-eastern Australia and because of the variability in northern Australian material (see Geographical Variation below), I believe it best not to select a neotype at this stage.

Typification of T. procerum var. gracile — In his account of *T. procerum* var. *gracile*, Micheli included two distinct species, citing "(*T. lineare* Endl.; *T. dubium* Brown ex specimine in herb. Brown in Brit. Mus. servato)". The meagre varietal description could be applied to either of the cited species although, because of its reference to the flowers being remote on the spike, it perhaps favours *T. dubium*. As Micheli directly refers to Brown's specimen preserved at the British Museum, that specimen(s) must be regarded as the type of Micheli's varietal name and it is necessary to exclude *T. lineare* Endl. from the circumscription of that variety.

In the paragraph beneath his account of the variety Micheli cites several collections. However, it is evident from the content that this paragraph, the final one in his account of *T. procerum* R.Br. *sensu lato*, refers to that species overall (as circumscribed

by Micheli) and is not part of the varietal account. It is incorrectly included by Chapman (1991b; p. 2905) as part of the type citation for *T. procerum* var. *gracile*.

It is puzzling why Micheli referred directly to Brown's specimen of *T. dubium* in the British Museum, rather than to just the species name *T. dubium*, when publishing his variety *T. procerum* var. *gracile* in 1881. It suggests that he saw Brown's specimen although Bentham had not been able to locate it three years earlier for his publication of the priorital name, *T. procerum* var *dubium*. Apparently none of Brown's original material exists today although, in my discussion of the typification of *T. procerum* R.Br., I have suggested that two very meagre collections mounted with the lectotype of *T. procerum* may actually be part of the type collection of *T. dubium*.

Type description of T. pterocarpum — The published description of *T. pterocarpum* Fitzgerald differs in one important respect from Fitzgerald's handwritten manuscript description held at the British Museum (BM). I have seen a copy of the manuscript and this clearly gives the length of the perianth segments as "1–1 1/2 lin. [linea] long". This measurement is equivalent to c. 2.1–3.15 mm and fits the taxon. The published description erroneously gave perianth segment length as "1–1 1/2 in.", i.e. equivalent to c. 25–38 mm, a gross oversize.

Geographical Variation — Plants from tropical Australia exhibit extremes of leaf and carpel variation not found in those from southern areas. They often have narrow, terete or semi-terete leaves only mildly flattened over the distal portions. When totally submerged, leaves may be <1 mm wide, flaccid and almost filamentous. When more or less linear, the leaves are narrower than, or in the narrower range of, similar shaped leaves from extra-tropical material.

Mature carpels from tropical plants are usually much larger and often more narrowly lanceoloid than those from southern plants. Near-mature carpels (10–)15–19 mm long occur on both Western Australian and Northern Territory specimens and apparently would have lengthened a little before maturing and falling naturally. The largest mature carpels seen, c. 20–21 mm long, are from more or less terete-leaved plants from the Kimberley (Aston 2696).

A terminal anther appendage is sometimes present on tropical plants, e.g. minute on *Lazarides 8988*, pronounced on *Dunlop 3274* and *Henshall 3730*. This character has been investigated on only some collections but it can be either present or absent on different plants of similar vegetative morphology.

Although the most extreme, narrow, terete-leaved, large-carpelled plants of the Kimberley superficially look very different to the broadest, flattened-leaved, small-fruited plants of Victoria, the gradation and overlap between these extremes is considerable throughout the intervening geographical range. There seems to be no consistent link between different morphological characters sufficient to warrant taxonomic segregation.

Diagnosis

The free, straight, narrowly lanceoloid to obloid carpels which virtually lack dorsal and lateral ridges and are more or less circular in cross section are distinctive. Those from northern Australia, particularly from the Kimberley, which reach 20 mm or so in length also exceed the size attained by the carpels of any other *Triglochin* species.

Field Observations

Apart from the distinctive fruits, *T. dubium* is noticeably different from *Triglochin multifructum* when found growing with that species in south-eastern Australia. See Aston 1993, p.94.

Fruit development can be extremely rapid. At one site near Beagle Bay, Western Australia, most fruits throughout the population were just commencing development when first examined (*Aston 2697*). Four days later most fruits were half developed, being 10–12 mm long (*Aston 2699*). A.H.Marshall of Waaia, near Numurkah, Victoria, reported (*in litt.*, July 1992) that with locally-collected fruits he "can grow a plant from seed up to setting seed in five months. If kept in water [plants] will grow all the year round and flower in autumn as well as in spring".

Marshall also reported (*in litt.*, Sept. 1992) that populations in essentially grazing farmland in the Nathalia district, Victoria, can withstand cropping at intervals. For one such population (*A.H.M. s.n*, 15 Oct. 1989) the rhizomes and tubers are too deep to be affected by the soil disturbance of cropping and plants "just take off" from subterranean parts when it gets wet enough. Plants can remain dormant underground for several years until conditions are suitable and can produce leaves but not flower if water does not cover them. The depression occupied by this population is inundated to a depth of at least 2 metres for a couple of weeks in years of big floods.

T. dubium has been found heavily grazed by cattle (*Aston 2804*, Katamatite, Victoria).

Three collections from Western Australia and the Northern Territory report that the tubers are eaten by aboriginal people. *Smith 85.34* (Beagle Bay, W.A.) states "Edible tubers eaten raw or after warming in hot ashes". *Reeve 120* (Nangalala to Gattji, N.T.) states "Tubers eaten after cooking".

Triglochin huegelii (Endl.) Aston *comb. nov.*

Cycnogeton huegelii Endl., *Ann. Wiener Mus. Naturgesch.* 2: 211 (1839, not Dec. 1838). TYPE: "In fluvia Cygnorum (Upper Swan-River) legit Carolus L.B. Hugel." TYPE MATERIAL: No specimens located at BM, K, LD, M, S, or W. **LECTOTYPE (here designated)**: *Iconogr. gen. pl.* VII: t.73 (1839). "Habitat in Novae Hollandiae colonia Swan-River. (Hugel.)". See discussion under notes below.

Triglochin procerum var. *eleutherocarpum* Benth., *Fl. Austr.* 7: 168 (1878), **syn. nov.**. TYPE: "W. Australia, *Drummond, n. 314, Preiss, n. 2405*; Blackwood and Tweed Rivers and Port Gregory, Oldfield." **LECTOTYPE (here designated)**: Swan River, *Drummond 314* (K)! ISOLECTOTYPES: (BM, MEL 720277)! REMAINING SYNTYPES: Port Gregory, W. Australia, *Oldfield* (K, MEL 720279)! Blackwood River, W. Aust., *Oldfield* [623 has been added to Oldfield's original label] (K)! Tweed River, W. Australia, *Oldfield* [623 has been added to Oldfield's original label] (MEL 720278)! *Preiss* 2405 (LD!, MEL 720280!, S — photocopy!).

Rhizomes (available on only one collection) to c. 14 mm diam., bearing moderately coarse fibres to 10 cm long. *Tubers* (available on two collections only) ellipsoid to obovoid, 8–25 mm long × 4.5–8 mm diam. (length 1.8–3 times the diam.), terminating roots 20–30 mm long; each root 2.0–3.0 times as long as its tuber. *Leaves* 38–89 cm long × 3–20 mm wide, dorsiventral, with floating extremities at least on plants growing in deeper water [collector's notes], sheathed over the lower 26%–34% of the leaf length. *T.S. leaf about 3 cm below the sheath summit*: not available from fresh or spirit material; apparently plano-convex with sheaths not touching. *Stems* in fruit 45–130 cm long (including the infructescence) × 3–9 mm diam. *Rachis* 1.5–6 mm diam. at base, gradually tapered upwards. *Infructescence* 5.5–46 cm long (= 18%–37% of the total stem length) × 12–23 mm diam. *Pedicels* 0.5–4 mm long, spreading to upturned. *Fruits* usually well-spaced (by up to 4.5 cm) on basal portion of rachis but elsewhere loosely touching, (16–)40–166 per infructescence, 2.8–5.3 per 1 cm of rachis length, ± globular in outline but distorted by the varied ways in which the free carpels spread or overlap, 8.5 mm long × 6.0 mm diam. (5–9 mm × 5–10 mm when dry). *Carpels* (2 or)3–6, in fruit erect or very slightly twisted, strongly incurved and usually overlapping each other, 1–6 maturing, often 2–4 aborting, 6.0–8.7 mm long × 1.3–2.3 mm wide × 2.1–3.5 mm deep (but the length 9.0–14.1 mm when measured around the carpel curvature); carpels free; lateral faces ± flat; dorsal ridge prominent (12%–25% of carpel depth), narrow-rounded; shoulder ridges conspicuous (15%–20% of carpel width), narrow-rounded. (Fig. 7a-f)

SELECTED SPECIMENS EXAMINED (total examined = 35)

Western Australia — Blackwood River, Bridgetown, 11 Dec. 1961, *Aplin 1365* (PERTH); Lake Seppings, Albany, 30 Sep. 1984, *Cranfield 4937* (CANB, MEL, PERTH); c. 2 km NW of junction of Regan Ford and Gin Gin Brook East roads, 30 Nov. 1974, *Halliday 176* (AD, MEL, PERTH); Helena River, 16 Oct. 1977, *Seabrook 355* (CANB, PERTH); Kerridale Swamp N of Augusta, 16 Nov. 1982, *Strid 21528* (PERTH).

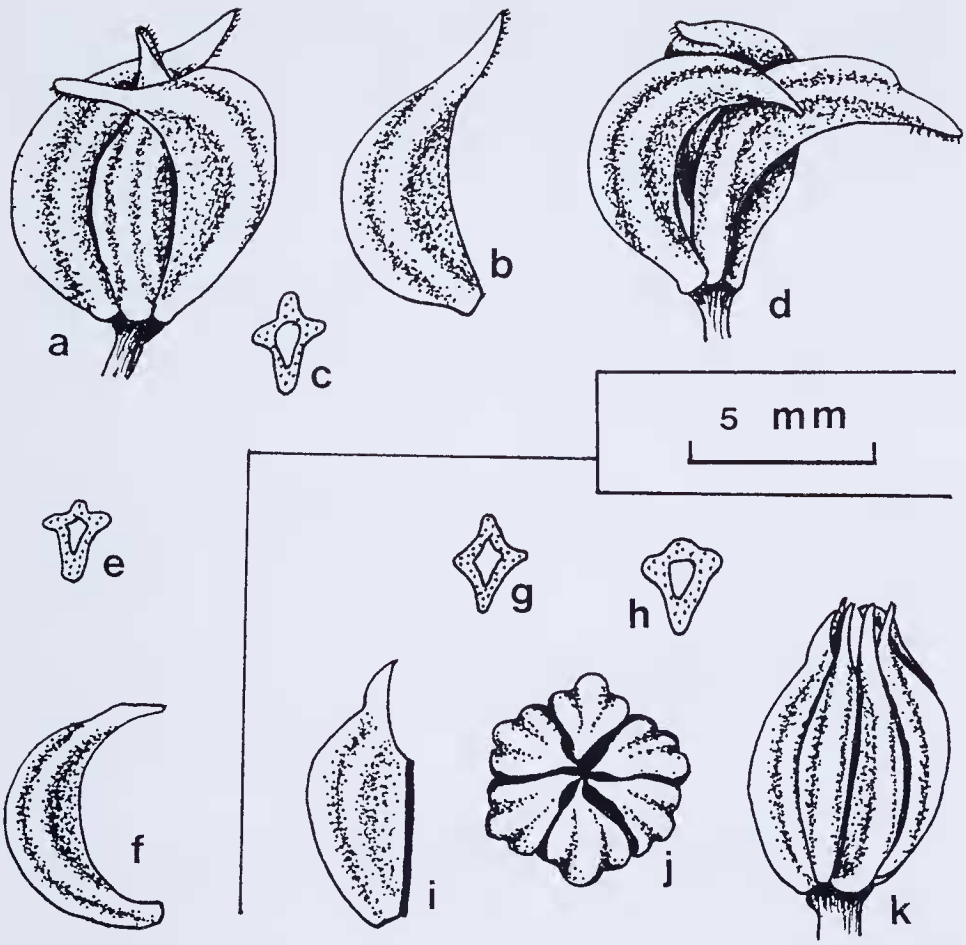

Fig. 7. Fruits and mature carpels. Attachment length shown by a thickened line on carpels in lateral view. a-f — *Triglochin huegelii*. a — 3-carpelled fruit, lateral view. b-c — carpel, lateral view and T.S. d — 3-carpelled fruit, lateral view. e-f — carpel, T.S. and lateral view. g-k — *Triglochin lineare*. g — carpel, T.S. h-i — carpel, T.S. and lateral view. j-k — fruit, apical and lateral views. (a-c — from *Cranfield 4937*. d — from *Strid 21528*. e-f — from *Aplin 1365*. g — from *Hnatiuk 771429*. h-k — from *Bates 4285*)

DISTRIBUTION (Fig. 8)

Confined to south-west Western Australia; recorded south and west of a line approximately through Gregory, Lake Wagin and Cape Arid.

HABITAT

Fresh, still to flowing water to 1 metre deep, mostly edging permanent lakes streams and rivers but also reported from [ephemeral?] swamps, pools and a roadside ditch; once collected from brackish flowing water (Regan's Ford; *Mann 188*). In mud, sand, or peaty-sand. Sites recorded as *Melaleuca raphiophylla* swamp (*Strid 21528*), pool surrounded by low heath (*Wilson 12411*); associated species *Juncus* (*Halliday 176*), and "aquatic herbfield".

Only one altitude of 60 m recorded.

Flowers July to January, chiefly August to November. Fruits July to January, chiefly August to December, with one collection in March.

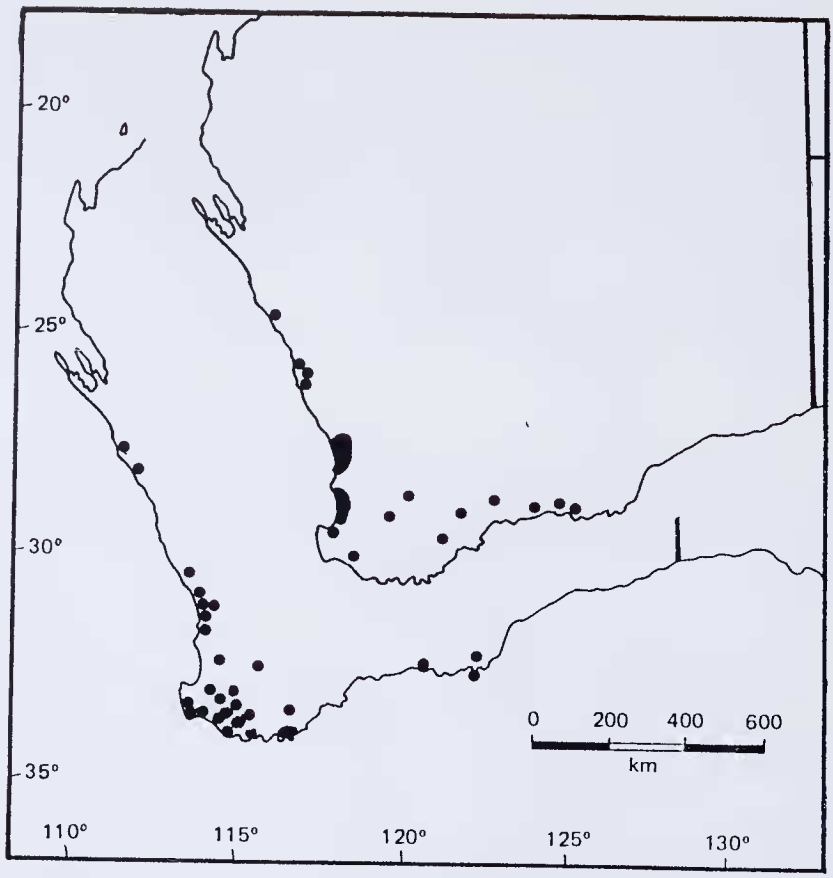

Fig. 8. Distribution of *Triglochin huegelii* and (inset) of *T. lineare*.

NOTES

Typification — In *Ann. Wiener Mus. Naturgesch.* 2: 210–211 (1839) Endlicher gave consecutive descriptions for the new genus and species *Cycnogeton* and *C. huegelii*. Under the generic name he referred to "Cycnogeton *Endlicher Gen. plant. Suppl. n. 1664/1. Iconograph. t. 73.*". The second of these references, the *Iconograph*, was published (Feb.- April 1839) in the same year as the *Annalen* but the first was not published until about two years later (Feb.- March 1841).

Under the specific name in the *Annalen* Endlicher cited "In fluvia Cygnorum (Upper Swan-River) legit Carolus L.B. Hugel." thus typifying both the species and the genus. His major type material would be expected at the Vienna Herbarium (W) but all Juncaginaceae there was destroyed during the second world war (Riedl 1981). No other possible type specimens have been located elsewhere. Plate 73 of *Iconogr. gen. pl.* consists of detailed botanical drawings captioned "*Cycnogeton Hugelii. E.*" and drawn from "Habitat in Novae Hollandiae colonia Swan-River. (*Hugel*).". As part of the original material used and cited by Endlicher, the plate is therefore a suitable lectotype for both the genus and species involved.

I have now (above) formally designated *Iconogr. gen. pl. t.73* as **lectotype** of the name *C. huegelii* Endl., and hence also as **lectotype** of the name *Cycnogeton* Endl. Although Chapman (1991a, p. 862) accepted the same plate as lectotype he incorrectly attributed the lectotypification to Endlicher himself, in the *Iconograph*. In 1839 the concept of lectotypes did not exist and, even if it had, it could not then have been applied by Endlicher to *C. huegelii* as type (plant) material was presumably still extant.

Endlicher, *Nov. stirp. dec.* Nr 9: 78–79 (20 July 1839), repeated exactly the generic and specific descriptions given in the *Annalen* cited above. Although the month of publication of the *Annalen* is undefined it is generally taken that this work has precedence over the *Nov. stirp. dec.* Endlicher himself seems to have accepted the *Annalen* as the major place of publication of the descriptions of *Cycnogeton* and *C. huegelii* as he cited it but not the *Nov. stirp. dec.* in his later *Gen. pl. Suppl 1.* p. 1369 (1841).

Morphology — See Notes under *T. lineare* concerning stamen size.

Diagnosis

Mature carpels of *T. huegelii* are distinctively free, strongly incurved, and with prominent narrow-rounded dorsal and lateral ridges. Commonly 1–6 carpels mature in each fruit, the remainder aborting their development. Fruits with 5–6 mature carpels are more or less globular in outline but distorted by the varied spreading or overlap of the free carpels. Infructescences, particularly the larger ones, characteristically have one to a few of the basal fruits isolated centimetres apart along the rachis.

Triglochin lineare Endl. in Lehmann, *Pl. Preiss.* 2: 54 (1846). *Cycnogeton lineare* (Endl.) Sonder, *Linnaea* 28: 225 (1856). Type: "In depressis bieme inundatis ad fluvium Cygnorum, Middle Sevon [Swan]., 1. Jul. [1839]. Herb. *Preiss. No. 2406.*". **Lectotype (here designated)**: "2406. / In depressis bieme inundatis / ad fluvium Cygnorum (Middle / Swan) / Fl.virides. / Jul.1.39 / L. Preiss legit." (LD)! Isolectotypes: [*Preiss*] "*2406*" (LD, MEL 720281 & 720282)!. No types present at BM, K, M, S or W.

Triglochin procerum var. *gracile* Micheli in A.DC. & C.DC., *Monogr. phan.* 3: 108 (1881) *pro parte, excl. typus, nom. illeg.* See Notes under *T. dubium.*

Triglochin procerum var. *procerum*, *sensu* B.L. Rye in N.G. Marchant *et al.*, *Fl. Perth Region* 2: 722 (1987) and in J.R. Wheeler, ed., *et al.*, *Fl. Kimberley Region* p. 973 (1992), *non sensu stricto.*

Triglochin procerum "WA", Aston *in litt.*

Rhizomes to 3 cm long × 6–13 mm diam., bearing short fine soft fibres to 2 cm long. *Tubers* ± ellipsoid or globular to obovoid, sometimes broadly so, 9–28 mm long × 6–11 mm diam. (length 1.2–3.7 times the diam.), terminating roots 11–45 mm long; each root 0.7–3 times as long as its tuber. *Leaves* 23–73.5 cm long × 1.5–5(–10) mm wide, (from dried material apparently not dorsiventral, submerged or floating, shortly tapered and acute, thin-textured, possibly somewhat thickened and spongy toward the base), sheathed over the lower section. *T.S. leaf about 3 cm below the sheath summit*: not apparent from dried material. *Stems* in fruit 18.5–60 cm long (including the infructescence) × 1–4.5 mm diam. *Rachis* 0.75–2.5 mm diam. at base, gradually tapered upwards. *Infructescence* 3.5–14.5 cm long (= 14%–39% of the total stem length) × 7–17 mm diam. *Pedicels* usually upcurved, 1–2.5(–3.5) mm long, rarely absent and the fruits then sessile. *Fruits* loosely touching to shortly-spaced, erect to semi-erect or rarely spreading, 10–47 per infructescence, 2.6–4.2 per 1 cm of rachis length, ellipsoid to ellipsoid-obloid in outline, 6.5–9.6 mm long × 4.1–6.1 mm diam. (5.5–9.0 × 2.5–4.75 mm when dry). *Carpels* 6, straight and erect in fruit (occasionally the distal portions somewhat twisted around each other when the carpels are only shortly connate), normally all maturing, occasionally 1–3 only semi-developing, 6.3–9.6 mm long × 1.5–1.9 mm wide × 2.1–2.7 mm deep (6.2–7.7 mm long when dry); ventral edges characteristically attached along their whole length (excluding the beak sinus) but sometimes the attachment considerably less; attachment length = (27%–)46%–72% of carpel length; lateral faces ± flat, adpressed; dorsal ridge inconspicuous to prominent, rounded, (2%–)9%–18% of carpel depth; shoulder ridges rounded, 5%-17% of carpel width. (Fig. 7g–k)

Selected Specimens Examined (total examined = 42)

Western Australia — Langford, Perth, 27 Sep. 1984, *Bates 4285* (AD); 8 km S of Eneabba, 27 Sept. 1977, *Hnatiuk 771429* (PERTH); Lowden, Oct. 1909, *Koch 2012* (NSW); Lort River, c. 65 km W of Esperance, 9 Oct. 1968, *Orchard 1417* (AD, PERTH); 10 miles N of Busselton at turnoff to Ruabon, 22 Sept. 1966, *Scrymgeour 1294* (PERTH).

DISTRIBUTION (Fig. 8)

Confined to south-west Western Australia; recorded south and west of a line approximately through Geraldton, Dumbleyung and Esperance.

HABITAT

Fresh, usually still and ephemeral water to 40 cm deep, in swamps, roadside ditches and low-lying floodland, also occasionally in small streams and creek pools; once reported from brackish river water (Hill River, *Parker 367*). In mud or sand but most frequently in clay soils; once reported from creek pool among granite rocks (*George 9465*). Sites recorded in *Banksia/Melaleuca* shrubland, low heathland, and with *Melaleuca hamulosa* surrounded by *Eucalyptus tetragona/Macrozamia riedlei.*

Only one altitude of 95 m recorded.

Flowers May to November. Fruits June to December. Most records for both flowers and fruits are from July to October.

NOTES

See Notes on typification under *T. dubium* concerning the exclusion of *T. lineare* from the circumscription of *T. procerum* var. *gracile* Micheli.

Marchant *et al.* (1987) state "stamens ca 1 mm long" for *T. lineare* compared with "stamens 1.5–2 mm long" for the sympatric species *T. huegelii*. I have not fully investigated this feature.

DIAGNOSIS

T. lineare is a comparatively small and slender species. The characteristic ellipsoid to ellipsoid-obloid, loosely touching to shortly spaced fruits, with usually 6 straight, erect, mostly well-connate, mature carpels are distinctive.

Triglochin microtuberosum Aston, *Muelleria* 8: 88 (1993).

TYPE: "Victoria, East Gippsland, 'Redbanks' farm, c. 2 km south-east of Genoa, 37°28′S, 149°36′E. .... 23 Feb. 1988, *H.I. Aston 2683*". HOLOTYPE: MEL 705958. ISOTYPES: AD, BRI, CANB, MEL 705961 & spirit material, NSW.

Rhizomes horizontal, to 7 cm long × 6–12 mm diam., bearing short coarse bristly fibres to 12 mm long. *Tubers* near-globular to obloid or rarely obovoid, 4.5–13(–17) mm long × 3–6 mm diam. (length 1.1–1.9(–5) times the diam.), terminating roots 1–7(–14) mm long; each root 0.2–2 times as long as its tuber [tuber rarely elongate, spindle-shaped, to 30 mm long × 3 mm diam., on roots to 28 mm long]. *Leaves* 30–137 cm long × 3–12 mm wide, dorsiventral, deep green above, paler green beneath, emergent, erect or with the extremities outcurved, sometimes the emerged portion fully floating or recurved with only the extremity floating, tapered and flattened distally, acute, very thickened and spongy toward the base, sheathed over the lower 27%–49% of the leaf length. *T.S. leaf about 3 cm below the sheath summit*: broadly plano- to concavo-convex and ± semi-cylindrical, width 1.6–2.4 times the thickness; each side of sheath 3.4–9.0 mm wide, equal c. 50%–84% of the leaf width, the two sheaths usually touching to overlapping; blade and sheaths together ± rounded in outline. *Stems in fruit* 54–124 cm long (including the infructescence) × 2.5–12.6 mm diam. *Rachis* 1.5–4.0 mm diam. at base, gradually tapered upwards; rachis and pedicels green. *Infructescence* 7–21 cm long (= 10%–20% of the total stem length) × 15–24 mm diam. *Pedicels* 0.5–3.0 mm long. *Fruits* touching, 44–137 per infructescence, 7–9 per 1 cm of rachis length, very widely obovoid in outline but with the base contracted into a distinctive stalk, 7.0–9.6 mm long × 5.5–8.2 mm diam.. *Carpels* (5 or)6, in fruit straight and erect, never twisted, normally all maturing, 7.0–9.6 mm long × 2.25–3.35 mm wide × 2.6–3.75 mm deep; ventral edges attached along their whole length (excluding the beak sinus); attachment length = 58%–70% of carpel length; lateral faces ± flat, adpressed; dorsal ridge absent, the dorsal face usually shallowly concave longitudinally or sometimes shallowly convex; shoulders rounded not ridged; carpel ± triangular in cross section. (Figs 2k-l, 3m-o, 9a-f)

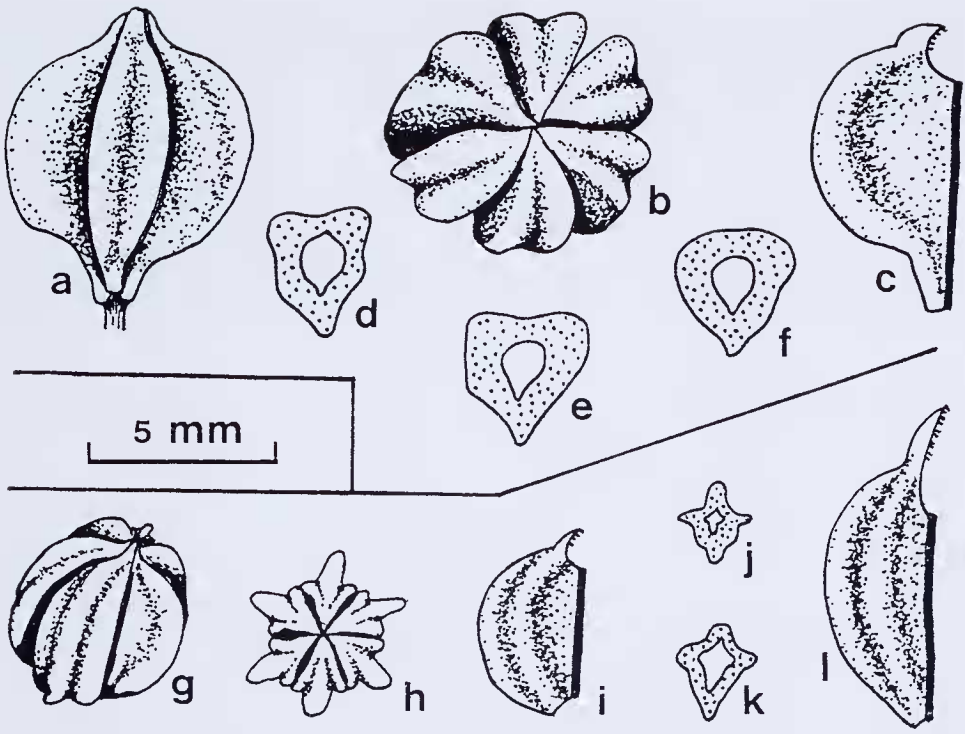

Fig. 9. Fruits and mature carpels. Ventral attachment shown by a thickened line on carpels in lateral view. a-f — *Triglochin microtuberosum*. a-b — fruit, lateral and apical views. c-d — carpel, lateral view and T.S. e-f — carpels in T.S. g-l — *Triglochin multifructum* from Victoria (g-j) and Byfield, Queensland (k-l). g,h — fruit, semi-lateral and apical views. i-j — carpel, lateral view and T.S. k-l — carpel, T.S. and lateral view.(a-d — from *Aston 2683*. e-f — from *Aston 2685*. g-h — from *Aston 2779*. i-j — from *Aston 2797*. k-l — from *Anderson 4022*)

DISTRIBUTION (Fig. 10)

Near-coastal regions from the vicinity of Brisbane, South-east Queensland, to Sale in eastern Victoria.

NOTES

See Aston (1993) for fuller information on this species.

When dry, the distinctive stalk of approximately the basal quarter or third of the fruit is narrowed through shrinking and may superficially be mistaken for an extension of the pedicel. The remainder of the fruit then appears depressed-globular.

T. microtuberosum often occurs in highly eutrophic water. One apparently healthy vegetative collection *Jacobs 4574* (NSW) from central-coastal New South Wales was taken from a farm dam that had been "repeatedly sprayed with herbicide".

DIAGNOSIS

T. microtuberosum has numerous small distinctive tubers terminating very short roots so that the tubers are clustered closely against the rhizome. The more or less pear-shaped fruit with squat summit, stalk-like base and absence of dorsal ridges is also distinctive, the (5 or)6 carpels being ventrally attached over most of their length and more or less triangular in cross-section.

A helpful characteristic, although partly shared with the eastern variant of *T. procerum*, is the more or less cylindrical shape of the lower leaf as seen in cross-section below the sheath summit. Here the leaf blade is thickly spongy, i.e. the blade is deep in comparison with its width, and the sheaths are curved and usually touching to overlapping.

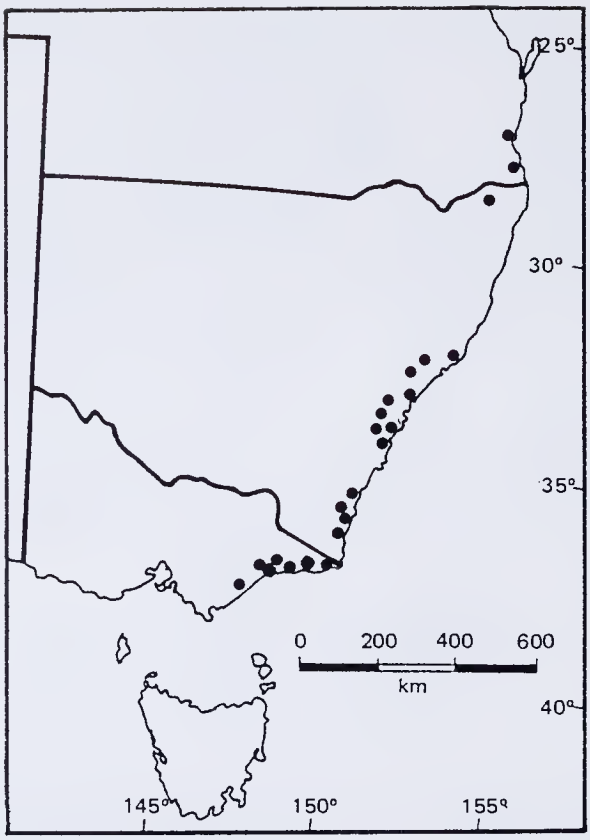

Fig. 10. Distribution of *Triglochin microtuberosum*.

Triglochin multifructum Aston, *Muelleria* 8: 90 (1993). TYPE: "New South Wales, c. 11 km ± north-east of Barham, 35°34′01″S, 144°12′06″E. .... 19 Apr. 1987, *H.I. Aston 2656*" HOLOTYPE: MEL 705960. ISOTYPES: AD, BRI, CANB, MEL 705959 & spirit material, NSW.

Rhizomes horizontal to upcurved, to 11.5 cm long × 14–18 mm diam., bearing long fine soft fibres 1–6 cm long. *Tubers* narrow-ellipsoid or narrow-obovoid to ellipsoid or obovoid, rarely broad-obovoid, 13–40 mm long × 4–14 mm diam. (length 1.3–5.2 times the diam.), terminating roots (8–)20–100 mm long; each root 1–4(–5.7) times as long as its tuber. *Leaves* 43–133 cm long × (2–)3.5–17(–34) mm wide, dorsiventral, deep green and glossy above, paler yellowish-green below, floating or sometimes with an emerged curve or with the extremities of younger shorter leaves emergent and erect, shortly tapered, obtuse-acute, thickened and spongy toward the base, sheathed over the lower 14%–20% of the leaf length. *T.S. leaf about 3 cm below the sheath summit*: narrowly plano- to concavo-convex, width 4.3–6.5 times the thickness; each side of sheath 2–6 mm wide, equal c. 20%–40% of the leaf width. *Stems* in fruit (28–)41–112(–175) cm long (including the infructescence) × 3.5–15 mm diam. *Rachis* (1.3–)2.3–5.5(–9) mm diam. at base, gradually tapered upwards; rachis and pedicels usually pale to deep maroon-cyclamen, or sometimes the rachis pale cream-green. *Infructescence* (5.7–)12–36.5(–110) cm long (= 17%–46%(–63%) of the total stem length) × 10–19 mm diam.. *Pedicels* 1.1–4 mm long. *Fruits* tightly touching, 229–c. 1000 per infructescence, 14–27 per 1 cm of rachis length, globular in outline, 3–5 mm long × 3–5 mm diam. (but fruits usually more ellipsoid and 4.5–8.5 mm long outside Victoria and New South Wales). *Carpels* 6(–8), straight and erect in fruit, normally all maturing, rarely 1 aborted, 3–5 mm long × 0.9–1.5 mm wide × 1.1–2.25 mm deep; ventral edges attached along their

whole length (excluding the beak sinus); attachment length = 57%–75% of carpel length; lateral faces ± flat, adpressed; dorsal ridge prominent, narrow-rounded (32%–42% of carpel depth); shoulder ridges inconspicuous before carpels separate but then seen in T.S. to be 15%–28% of carpel width. (Figs 2i-j, 3f-g, 9g-l)

Selected Additional Specimen Examined

Victoria — "Gum Swamp", 13.5 km W of Werribee, 15 May 1994, *Aston 2859* (MEL).

Distribution (Fig. 11)

Through eastern Queensland, eastern New South Wales, and northern Victoria, rarely in southern Victoria. Recorded once in the Northern Territory (Gulf of Carpen-

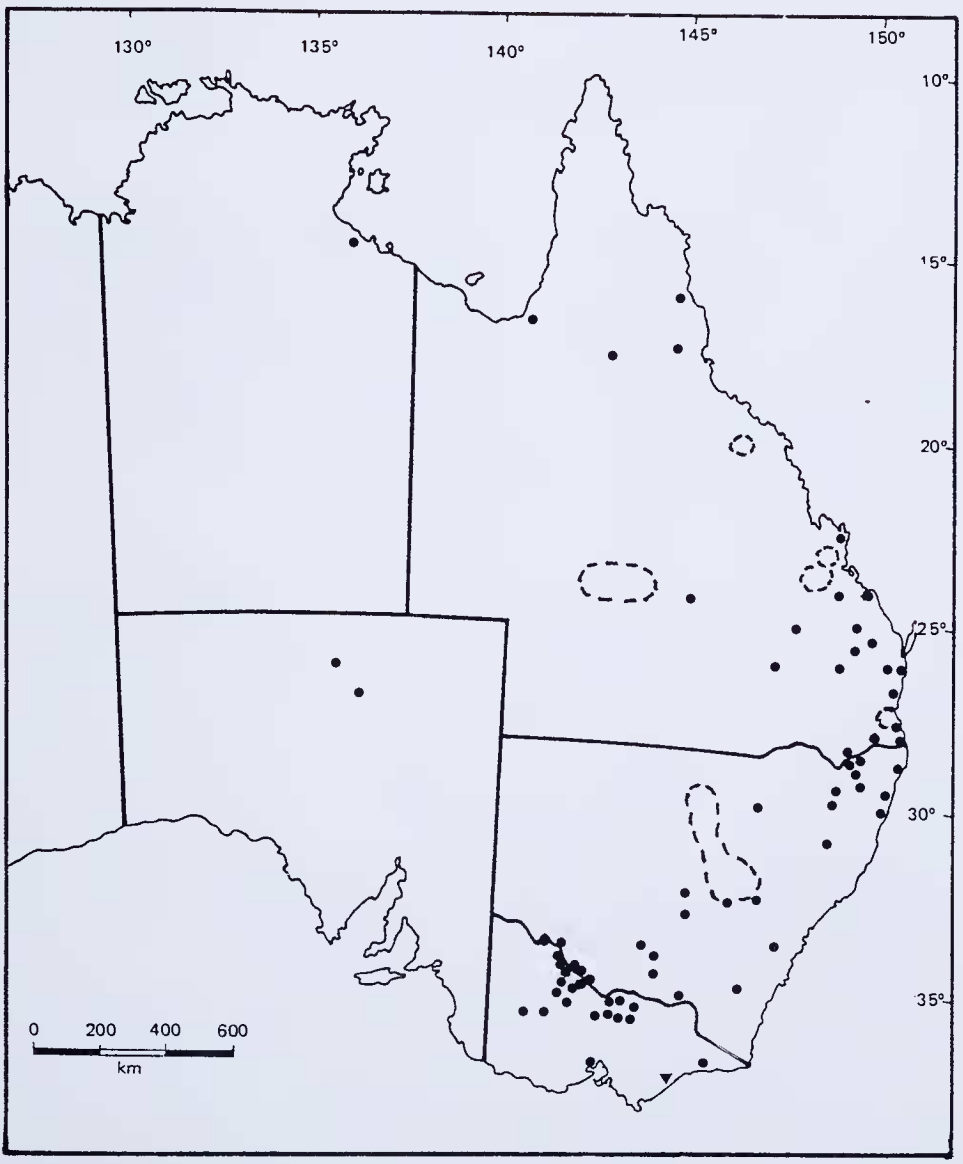

Fig. 11. Distribution of *Triglochin multifructum*. Triangle = a doubtful record. Dashed line = approximate position of an imprecise locality.

taria) and twice in South Australia (northern Lake Eyre Basin). Only recently located on the basalt plains west of Melbourne, southern Victoria. There found in similar habitat to places where *T. multifructum* occurs in northern parts of the State, and believed to be native to the area.

NOTES

See Aston (1993) for fuller information on this species.

DIAGNOSIS

Mature fruiting plants are readily distinguished in the field by the comparatively long infructescence with typical maroon-cyclamen rachis and numerous, small, tightly-touching fruits (c. 14–27 per 1 cm of rachis length). Within Victoria and New South Wales, mature fruits are typically only 3–5 mm long × 3–5 mm diam., globular in outline but strongly ridged. Elsewhere, fruits tend to be more ellipsoid in outline and generally somewhat larger, from 4.5–8.5 mm long. The 6(–8) carpels are ventrally attached along their full length except for the beak sinus and each has a prominent, narrow, dorsal ridge and two noticeable lateral rdges.

Triglochin procerum R.Br., *Prodr. Fl. Nov. Holl.* 343 (1910).

Cycnogeton procerum (R.Br.) Buchenau, *Abh. Naturwiss. Vereine Bremen* 1: 224 (1868). TYPE: "(J.T.) v.v.". **LECTOTYPE (here designated)**: "Triglochin maximum / Hawkesbury 1804", left hand specimen on sheet containing 3 collections, each with a label in R.Brown's hand, (BM)!. PROBABLE ISOLECTOTYPES: "[day indecipherable] Sept 1804" [Probably coll. R.Brown] (E)! [Probably coll. R.Brown] (E)! POSSIBLE SYNTYPES (= the two remaining collections on the lectotype sheet, here excluded from the circumscription of *T. procerum* R.Br.): "Triglochin / No 11 desc^{n} / Carpentaria. Main. [= mainland] opposite Groote Island. / Jan^{y} 4 desc 5, 1803"; "Carpentaria / Island h [= North Island, Sir Edward Pellew Group] / in paludo. Dec^{r} 20 / 1802" (BM)! Excluded as possible Syntype (separate sheet): "Nova Hollandia, Pt Jackson — Mr Brown" (BM)! No types located at G or G-DC, M, P, UPS, or W. See Notes below on typification.

Triglochin procerum agg., form C, Robb & Ladiges (1981).

Triglochin procerum "C" and "Cc", Aston *in litt.*

Description Excluding Eastern Variant — *Rhizomes* semi-horizontal, 4.5–18 cm long × 7–18(30) mm diam., bearing long fine to semi-coarse to coarsely stiff fibres. *Tubers* usually elongated, narrow-ellipsoid to cylindrical, less frequently ellipsoid to obovoid or obloid, 20–145 mm long × 4.5–13 mm diam. (length 2.5–20 times the diam.), terminating roots 37–139 mm long; each root 0.5–3.3 times as long as its tuber. *Leaves* 27–227 cm long × 7–41(–150 *n.v.*, western variant) mm wide, dorsiventral, dark green and glossy above, paler yellowish-green to mid-green beneath, floating or with an emerged curve or emergent and erect to semi-erect, shortly tapered, obtuse-acute, thickened and spongy toward the base, sheathed over the lower 14–34% of the leaf length. *T.S. leaf about 3 cm below the sheath summit*: ± transversely elliptic in outline including the sheaths, the central spongy portion narrowly plano- to concavo-convex with width 2.2–5.4 times the thickness; each side of sheath 5–18 mm wide, equal c. 33–59% of the leaf width. *Stems* in fruit 33–197 cm long (including the infructescence) × 4–23 mm diam. *Rachis* 2.5–9(–14, western variant) mm diam. at base gradually tapered upwards; rachis and pedicels usually pale cream-green to green, or sometimes the pedicels and rarely the rachis tinged maroon. *Infructescence* 6–51(–144, western variant) cm long (= 12–40%[–82%, western variant] of the total stem length) × 17–29(–42, western variant) mm diameter. *Pedicels* 1.7–5.2 mm long. *Fruits* touching, 67–320 per infructescence, 5–11(–18, western variant) per 1 cm of rachis length, globular to ellipsoid or rarely depressed-globular in outline, 6.8–14.4 mm long × 6.8–10.9 mm diam., the length 1.1–1.9 times the diam., rarely slightly < diam. *Carpels* 6(or 7), in fruit straight and erect to partly spiralled around each other and then giving a twisted appearance to the fruit, all maturing or with 1–2(rarely –5) only partially developing so that fruits may be asymmetrical, (6.4–)8.5–13.6 mm long × 2.35–3.4 mm wide × 3.2–4.9 mm deep; ventral edges attached along their whole length (excluding the beak sinus)

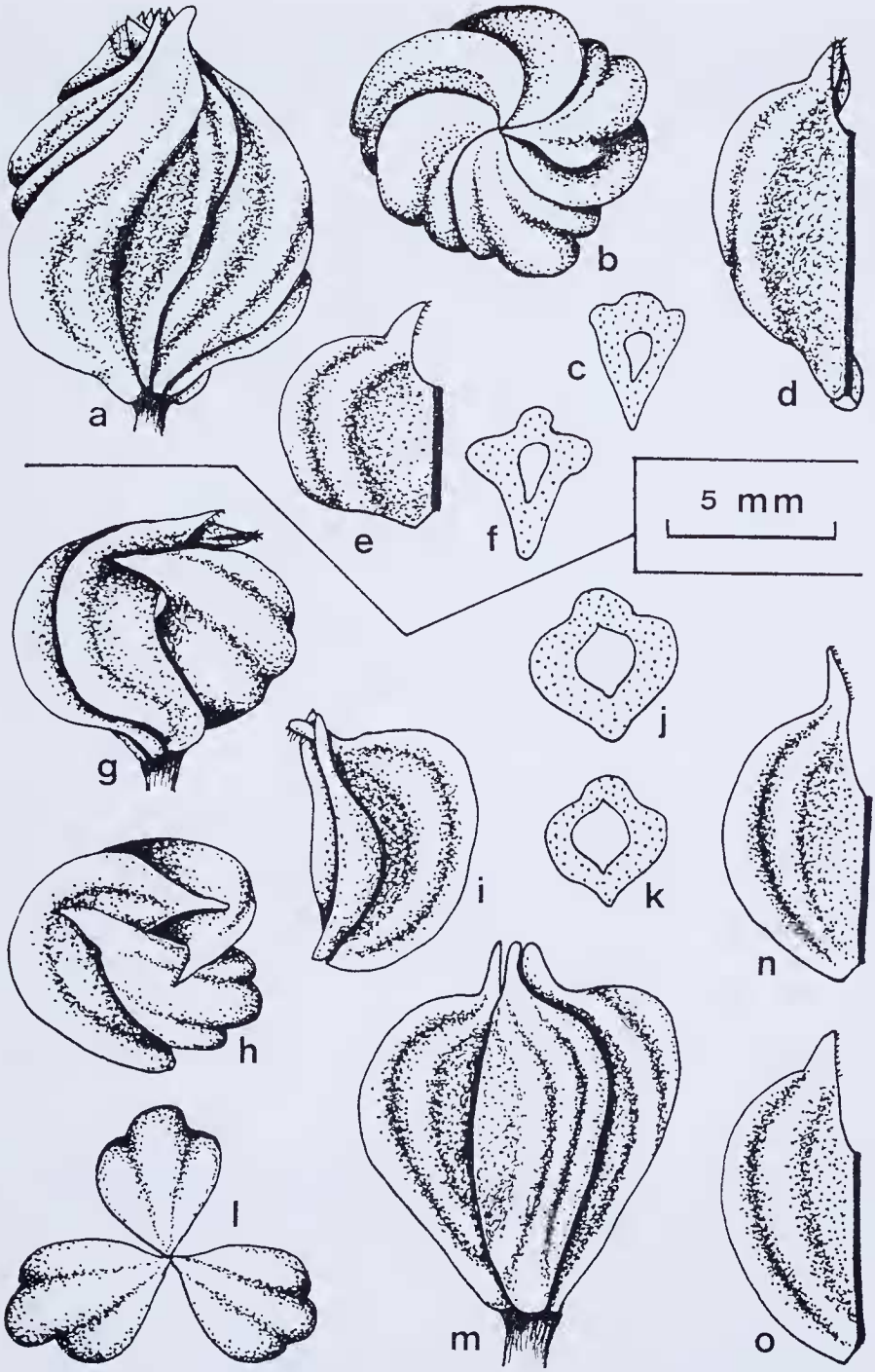

Fig. 12. Fruits and mature carpels. Attachment length shown by a thickened line on carpels in lateral view. a-f — *Triglochin procerum*, excluding variants. a-b — twisted-globular fruit of 6-carpels, lateral and apical views. c — carpel in T.S. d — carpel, lateral view, indicating spiralling. e-f — carpel, from broader, more squat, straight fruit, lateral view and T.S. g-o — *Triglochin procerum*, eastern variant. g-h — twisted-tapered, 3-carpelled fruit, lateral and apical views. i — 3-carpelled fruit with 2 aborted and 1 mature carpel, lateral view. j-k — carpels in T.S. l-m — straight-3-carpelled fruit, apical and lateral views. n-o — carpels, straight, lateral views. (a-d — from *Aston 2695*. e-f — from *Aston 2780*. g-o — from *Aston 2825*)

or becoming mechanically unattached distally in twisted fruits; attachment length = 55%–80% of carpel length or mechanically reduced to as little as 30% on strongly twisted fruits; lateral faces ± flat, adpressed; dorsal ridge prominent (7%–22% of carpel depth); shoulder ridges variable, in T.S. either not differentiated and continuous with the lateral faces or projecting and then 11%–28% of carpel width. (Figs 2a-c, 3a-b, 12a-f)

Partial Description of Eastern Variant — *Leaves* 53–163 cm long × 5–13 mm wide, emergent, stiffly erect to outcurved, usually standing well above the water surface, rarely floating, ± linear but gradually narrowed above the sheath then gradually widening and finally tapered distally, acute, greatly thickened and spongy toward the base, sheathed over the lower 21%-37% of the leaf length. *T.S. leaf about 3 cm below the sheath summit*: ± circular in outline including the sheaths, the central spongy portion broadly concavo-convex with width 1.6–2.4 times the thickness; each side of sheath 6.5–14 mm wide, equal c. 51%–99% of the leaf width and often overlapping each other in situ. *Stems* in fruit 56–158 cm long (including the infructescence) × 4.5–12 mm diameter. *Rachis* 2–4.5 mm diam. at base. *Infructescence* 9–32 cm long (= 11%–27% of the total stem length) × 18–30 mm diameter. *Fruits* 52–228 per infructescence, 5–10 per cm of rachis length. *Carpels* 3–6, in fruit straight and erect to sometimes slightly spiralled around each other, often strongly incurved and falcate, (1 or)(2 or)3–5(or 6) maturing, the remainder aborting or only partially developing, 7.7–13.7 mm long × 2.8–4.6 mm wide × 3.5–5.4 mm deep; ventral edges attached along the whole length excluding the beak sinus when carpels are straight and erect, but unattached distally when carpels are falcate and spiralled; attachment length 37%–66% of carpel length; lateral faces shallowly convex, only partially adpressed; dorsal ridges usually prominent (6%–22% of carpel depth), broadly obtuse. Plants otherwise essentially as given in the Description Excluding Eastern Variant above. (Figs 3c-d, 12g-o)

Selected Specimens Examined, excluding the eastern variant (total examined = 238)

South Australia — Boat Harbour Creek, between Cape Jervis and Victor Harbour, Fleurieu Peninsula, 16 Nov. 1957, *Eichler 14418* (AD!, H *n.v.*, L *n.v.*, MTJB *n.v.*); South West River, near bridge of South Coast Road, Kangaroo Island, 7 Nov. 1958, *Eichler 15291* (AD); NE of Penola, 17 Dec. 1961, *Hunt 573* (AD); 17 km NNE of Penola toward Penola Swamp, 5 Nov. 1981, *Munir 5495* (AD!, CHR n.v., COLD n.v.); Southern Bakers Range, 12 Nov. 1986, *Pillman 6874* per *Kinnear* (AD); Greenway Landing, River Murray, 16 Feb. 1984, *Thompson 52* (AD); Finnis River, just E of Mt Effie, southern Mt Lofty Range, 1 Nov. 1959, *Whibley 549* (AD! Z *n.v.*); N of Kingston, 11 Jan. 1982, *Williams s.n.* (AD); Ewens Ponds, c. 8 km E of Port MacDonnell, 19 Nov. 1959, *P. Wilson 1363* (AD!, NSW *n.v.*, PH *n.v.*, PNH *n.v.*, PRE *n.v.*, RSA *n.v.*); Mosquito Creek, off Penola to Naracoorte road, c. 18 km S of Naracoorte, 20 Nov. 1959, *P. Wilson 1372* (AD!, KW *n.v.*).

New South Wales — Little Plains River, c. 14 km by straight line ± ENE of Delegate, 19 Feb. 1990, *Aston 2829* (MEL, NSW); Wilbriggie State Forest, South Western Plains, 17 Dec. 1984, *McIntyre & Newnham MNSM275* (NSW); Nepean River, c. 4 miles [c. 6.5 km] S of Wallacia, 1 Dec. 1963, *Salasoo 2658* (NSW).

Victoria — Middle Creek, c. 12 km ± SE of Carisbrook, 23 Nov. 1987, *Aston 2672* (AD, CANB, HO, K, MEL) and *Aston 2673* (AD, CANB, HO, MEL); Joyces Creek (White Creek), c. 8 km by straight line ± W of Newstead, 23 Nov. 1987, *Aston 2674* (MEL, NSW); c. 2 km NE of Seymour, 27 Feb. 1988, *Aston 2695* (CANB, HO, MEL); Bungalally Creek, c. 7 km S of Horsham, 9 Nov. 1988, *Aston 2703* (BRI, CANB, MEL, PERTH); 2.4 km E of Dergholm, 12 Nov. 1988, *Aston 2725* (MEL, NSW); c. 3.5 km NNW of Piangil North, 17 Dec. 1988. *Aston 2735* (MEL); c. 11 km by straight line E of Streatham, 23 Feb. 1989, *Aston 2773* (MEL); c. 3 km SSE of Wood Wood, 5 Nov. 1989, *Aston 2780* (MEL); c. 3 km S of the Koondrook-Barham bridge over the Murray River, 6 Nov. 1989, *Aston 2782* (MEL); Lower Tostaree, East Gippsland, 19 Jan. 1992, *Aston 2834* (MEL).

Tasmania — Maria Island, 11 Dec. 1983, *Buchanan 2072* (HO); Tamar River at Dilston, 13 Oct. 1985, *Buchanan 7297* (HO); Lake Crescent, 18 Feb. 1971, *Curtis s.n.* (HO); Jordan River at Hunting Ground, 13 Jan. 1982, *Curtis & Allan s.n.* (HO); Gordon River, within a few miles of Macquarie Harbour, 21 Jan. 1949, *Garden NSW7321* (NSW); Gunn's Lake, N of Arthur's Lake, 16 Feb. 1981, *Moscal 646* (HO, MEL); Roaring Beach, Tasman Peninsula, 9 Feb. 1960, *Thorne 26954 & Carolin* (NSW!; RSA *n.v.*).

Selected Specimens Examined, eastern variant (total examined = 57)

Queensland — [North] Stradbroke Island, Eighteen Mile Swamp, 6 Jun. 1977, *Anderson s.n.* (BRI); Samuel Hill, c. 10 km WNW of Mt Atherton, 10 Jul. 1977, *Clarkson 956 & Stanley* (BRI); North Stradbroke Island, Eighteen Mile Swamp, 23 Nov. 1971, *Durrington 660* (BRI); Moreton Island, Eagers Swamp 13.5 km

SSE of Cape Moreton, 11 Oct. 1973, *Durrington 1251 & Levine* (BRI); 2 km N of Coolum Beach, c. 130 km N of Brisbane, 30 Nov. 1975, *Sharpe 1865* (BRI).

New South Wales — Wonboyn Creek, c. 22 km SSW of Eden, 12 Feb. 1990, *Aston 2811* (MEL); Swamp beside western tributary of Cullendulla Creek, c. 3.5 km NE of Batemans Bay, 17 Feb. 1990, *Aston 2825* (BRI, CANB, MEL, NSW); Dragon Swamp Creek, 0.2 km W of Cathcart, 19 Feb. 1990, *Aston 2828* (MEL, NSW); Port Macquarie, Oct.1893, *Bauerlen NSW228273* (NSW); Tabbigai, Kurnell Peninsula, 28 Aug. 1965, *Briggs NSW80707* (NSW); Kingsford-Smith Aerodrome, Mascot, 8 Jun. 1965, *Constable 5969* (NSW); Grassy Gully, Shoalhaven River, 3 Jan. 1932, *Rodway 9161* (K *n.v.*, NSW!);

Victoria — Between Marlo and Cape Conran, 2 km W of the turnoff to Burbang Caravan Park, 20 Jan. 1992, *Aston 2835* (CANB, MEL, NSW); Emu Creek, where crossed by the Marlo to Cabbage Tree Creek road, 21 Jan. 1992, *Aston 2837* (MEL, NSW); Barracoota Lake, ± 6 miles [10 km] direct ENE of Mallacoota, 6 Nov. 1969, *Beauglehole 31561* (MEL); ± 2 miles [3 km] SW of Bemm River township, 21 Feb. 1975, *Robinson s.n.* (MEL).

Distribution (Fig. 13)

An eastern variant occurs in coastal or near-coastal areas from near Rockhampton south through south-eastern Queensland and eastern New South Wales to near Orbost,

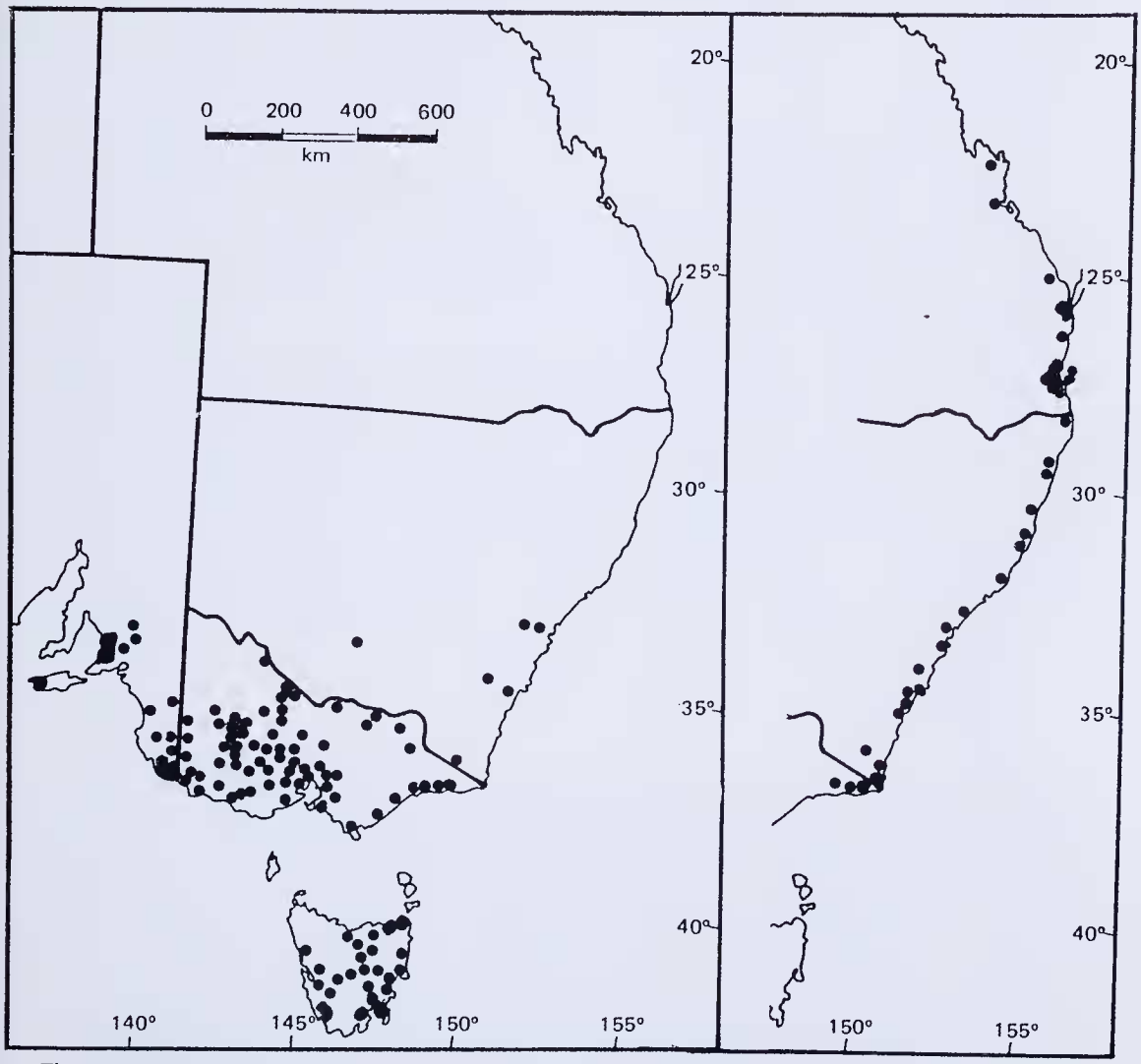

Fig. 13. Distribution of *Triglochin procerum*. Left = excluding the eastern variant. Right = eastern variant only.

East Gippsland, Victoria. A western variant occurs in south-eastern South Australia and Tasmania. Apart from these variants, distribution of the species is from Kangaroo Island, the southern Lofty, lower Murray and south-eastern areas of South Australia through most of Victoria (excluding the north-west and alpine regions) to the south-eastern quarter of New South Wales and in Tasmania.

HABITAT

Excluding the Eastern Variant — Fresh, still to slow-flowing, usually clear water to 1(–2) metres deep in mostly permanent swamps, lagoons, drains, stagnant waterholes, creeks and rivers, surviving on saturated to damp soils above receding waters. Water sometimes stained black from litter decomposition or semi-turbid. Rhizomes and roots embedded mostly in sandy to heavy grey clays overlain with several centimetres of soft silt sand or humus, also in heavy loams or deep fine silt or sand. Sites typically fringed by *Eucalyptus camaldulensis* (River Red Gum) or grazed farmland. One East Gippsland record (Aston 2840) from black silty peat with *Eleocharis sphacelata* and *Villarsia exaltata* in sedge swamp fringed with *Melaleuca squarrosa*, i.e., the usual habitat of the eastern variant. One Kangaroo Island collection (*Haegi 2327*) from a stream in *Eucalyptus obliqua*, *E. baxteri*, *E. leucoxylon* forest with *Leptospermum lanigerum*, *Gahnia sieberana*, *Pteridium* and *Blechnum* understorey. Associated species recorded are *Eleocharis sphacelata*, *Villarsia reniformis*, *Myriophyllum 'propinquum'*, *Triglochin multifructum*, *Potamogeton tricarinatus*, *Typha*, *Juncus*, sedges and herbaceous aquatics.

Common in lowlands from virtually sea level to c. 450 m altitude; also sparsely recorded to 760 m on the mainland and to 990 m in Tasmania.

Flowers all months, but chiefly September to February, on the mainland; recorded September to March, but chiefly October to December in Tasmania. Fruits September to June, chiefly September to March, on the mainland; recorded October to May, chiefly October to March, in Tasmania.

Eastern Variant — Fresh, still to slow-flowing, usually clear water to 1 metre deep in mostly permanent swamps, sedgelands and creeks; also in brackish coastal swamps. Water sometimes stained black from decomposition of leaf litter and one population (*Aston 2825*) located in highly polluted, reddish-black, humic and oily? water receiving industrial spillage. Rhizomes and roots embedded in loamy or humic sand or in sandy peat, less frequently in heavier loam. Sites typically in or fringed by *Melaleuca squarrosa*, *M. ericifolia*, *Leptospermum juniperinum*, *Gahnia* sp., *Casuarina glauca*, or *Banksia* scrub. Associated species recorded are *Eleocharis sphacelata*, *E. equisetina*, *Baumea rubiginosa*, *Leptocarpus tenax*, *Lepironia articulata*, *Empodisma minus*, *Restio tetraphyllus*, *Nymphaea stellata*, *Villarsia exaltata*, *V. reniformis*, and *Gleichenia* sp.

Commonly occurs from virtually sea level to c. 200 metres altitude, with one record (*Aston 2828*) from c. 800 metres.

Flowers and fruits recorded May to February.

NOTES

Typification of *T. procerum* — Robert Brown described *T. procerum* from material he collected in areas "(J.T.)". Area (T.) embraces two regions [see Typification under *T. dubium*]. One of these is the Carpentarian region, northern Australia. The common tuberous-rooted species of this region is *T. dubium*, which Brown recognised and described as distinct from *T. procerum*. There is only one other allied species, the newly-described *T. multifructum* Aston (1993), known from the Carpentarian region where it is apparently uncommon, having been collected there post-1970 from only two localities. It is therefore unlikely that Brown would have collected any tuberous-rooted *Triglochin* from the Carpentarian region other than *T. dubium*, or that he would have placed any such material within his species *T. procerum*.

The other region which Brown included in area (T.) is central eastern Queensland. *T. procerum*, as circumscribed here, now appears rare in this region. However, the entity commonly occurs in Brown's area (J.) which extends approximately between

Sydney and Newcastle, New South Wales, including the Hunter River and its branches (Stearn 1962). It therefore seems most probable that Brown's major collection(s) of his *T. procerum* would have been made in the vicinity of Sydney to Newcastle.

In his published diagnoses, Brown gives *T. procerum* as 6-carpelled [per flower or fruit] and *T. dubium* as 3-carpelled. I have seen two sheets sent on loan by the British Museum and regarded in their collections as type material of *T. procerum*. The sheet "Nova Hollandiae, Pt Jackson — Mr Brown" contains foliage and one inflorescence with 3-carpelled flowers. It therefore does not fit Brown's diagnosis of *T. procerum* and I exclude it from consideration as type material of this species. The second sheet has three collections made by Brown. The left hand specimen is a portion of scape and infructescence from which all mature fruits which may have been present have now vanished. A few partial or complete fruits in the earliest stages of development are adequate to show that they are 6-carpelled and I have designated this specimen, from Hawkesbury (= near Sydney), as **lectotype**. The two remaining collections on the lectotype sheet are of solitary scapes, lack all fertile parts, and cannot be identified with certainty by standard morphological means. Although cited above as possible syntypes of *T. procerum*, their smallness and localities make me suspect that they are portions of *T. dubium* and I have excluded them from the circumscription of *T. procerum*. It is even possible that they are part of the missing type collection(s) of *T. dubium* R.Br.

T. procerum as circumscribed here is very variable throughout its range and even within the complex which I have loosely grouped as an eastern variant. I cannot be certain which variation is represented by the meagre and immature lectotype specimen. Because the complex embraced within the eastern variant is apparently the most common within Brown's area (J.), it might be expected that the lectotype would represent some entity within this complex. However, the shape and the long attachment length of the immature carpels of the lectotype specimen could indicate that the latter represents *T. procerum* plants from outside the eastern variant complex. Future work and other techniques may show that further formal taxonomic segregation within the current circumscription is justified. If so, I predict that the designation of an "interpretive type" for *T. procerum* R.Br. will be necessary at that stage (Hawksworth 1994). Such a type should most appropriately originate from the area covered by Brown's area (J.) and should be representative of a taxon bearing 6-carpelled mature fruits.

Typification of *Cycnogeton procerum* — I have examined the unbound issues, still in their original paper covers, of *Abhandlungen herausgegeben vom naturwissenschaftlichen Vereine zu Bremen* in which Buchenau published his article "Index criticus Juncaginacearum hucusque descriptarum" and a brief supplement to it. The article appeared in Band 1, Heft 2, [Vol. 1, No. 2] pp. 213–222 (upper half of page only), published at the end of March 1867 ("Ende Marz 1867"). The supplement appeared a year later in Band 1, Heft 3 [Vol.1, No.3], pp. 222 (lower half of page only)-224, published at the end of March 1868 ("Ende Marz 1868"). As the new combination *Cycnogeton procerum* (R.Br.) Buchenau was made on page 224, i.e. in the supplement in Heft 3, its date of publication is March 1868, not March 1867 as given by Chapman (1991a).

The dates of publication given above for *Abh. Naturwiss. Vereine Bremen* are taken from a table of contents for each of the three hefts of Volume 1 published inside Heft 3. However, Stafleu & Cowan (1976, p. 390, entry no. 865) give the date of publication of all pages 213–224 as after September 1868. Although this is incorrect for pages 213–222 (upper half), it might be taken as correct for the critical page 224. A publication date of after September 1868 could compete with the 6 October 1868 publication date of Buchenau's *Index criticus Butomacearum, Alismacearum, Juncaginacearumque* in which (p. 50) the combination of *Cycnogeton procerum* (R.Br.) Buchenau also appears. Without additional evidence, and in agreement with Chapman (1991a), I accept that the *Abhandlungen...* has priority.

Morphological Variation — *Triglochin procerum*, as circumscribed here, is a highly polymorphic species which requires further study including experimental work. Without this, I believe that formal taxonomic segregation within this entity is currently unjustified and could lead to nomenclatural instability in the future. A brief discussion

of the variability of two characters, the mature fruit and the leaf in transverse section, is given here.

Four extremes in fruit shape (Fig. 12), namely large straight-ellipsoid, twisted-globular, straight-3-carpelled, and twisted-tapered are partly related to geographical distribution. The straight-3-carpelled and the twisted-tapered fruits both occur in an eastern variant distributed coastally from Queensland to eastern Victoria, the large straight-ellipsoid fruits occur in a western variant distributed in south-eastern South Australia and Tasmania, and the twisted-globular fruits are widespread from South Australia to New South Wales and in Tasmania. These four extreme kinds of fruit could well be attributed to distinct species except for the occurrence of numerous gradations between the extremes, even within the same population or on the one infructescence. See also Distribution and Field Observations.

Two extremes in leaf cross-section below the top of the sheath are also partly related to geographical distribution. Those of the eastern variant are approximately cylindrical in such section, with overlapping or touching sheaths, whereas those from plants elsewhere are narrowly to broadly elliptic with the sheaths not meeting across the ventral face of the blade (Fig. 3a-d). Although intergrades between these leaf extremes are evident, gradation between them does not seem as pronounced or as frequent as is the case with fruits. In addition, leaves of the eastern variant are almost always quite stiffly emergent and erect to outcurved, whereas elliptic-sectioned leaves are usually looped or trailing. Elliptic-sectioned leaves can, however, be erect or outcurved, particularly when they are of the widest diameters and are then most thickly spongy and have the greatest turgidity.

Fruits of the widespread, strongly-twisted, globular kind are often in populations bearing similar-sized, globular to ellipsoid, non-twisted to only slightly twisted fruits.

Diagnosis

See notes on morphological variation above.

The eastern variant is detectable in the field by its comparatively slender habit, usually erect leaves cylindrical at the base, carpel number often three, and carpel shape. The western variant has large, straight, elliptic, usually 6-carpelled fruits with the carpels attached along most of their length. The leaves, stems and infructescences are often exceptionally large and robust but in many cases they fall well within the smaller dimensions shown by the wide-ranging plants with more globular twisted fruits.

Field Observations

Excluding both Variants — As discussed in a previous paper (Aston 1993), *Triglochin procerum* frequently co-exists with *T. multifructum* and has also been observed growing intermingled with *T. alcockiae*.

Near Carisbrook, in central Victoria, two different growth-forms (*Aston 2672 & 2673*) grew intermingled in 10–30 cm of clear, slowly flowing, fresh water in a small creek. Plants of *Aston 2672* had broader, shorter leaves held erect above the water surface, the longer of them then looping down and their extremities floating. Flowering was over, all plants being in fruit. Fruits were large (10–13 mm long), green, with straight carpels or with the carpels slightly twisted on some infructescences. In contrast, plants of *Aston 2673* had narrower, longer leaves with all of their emerged portions trailing on the water surface and none rising above it. Flowering was still in progress, only about 50% of the stems bearing mature fruits. Fruits were small (6–7 mm long), dark brown-maroon, with the carpels strongly twisted. There was no noticeable ecological reason for the differences in growth-forms or for the consistent linkage of fruit size and shape with growth-form. Apparently at least some of the differences were genetically based.

Eastern Variant — The fruit variability shown by the eastern variant has been observed in the field within several populations in both Victoria and south-eastern New South Wales. Herbarium specimens indicate that this variability continues northwards into Queensland. For example, *Durrington 660* has different fruits (more squat,

straighter, shorter stylar beaks) to those of *Anderson s.n.* (more elongated, strongly twisted, longer projecting stylar beaks) but both collections are from the same swamp on Stradbroke Island.

Fruit variability is well illustrated by plants observed within a diameter of six metres in a swamp near the Burbang Caravan Park (*Aston 2835*) and along an eight metre line within Emu Creek (*Aston 2837*), both these sites being near Marlo, Victoria.

At the Burbang site, each fruit usually had either 3, 4 or 5 mature carpels but frequently there were only 2; sometimes only 1 or else all 6 carpels matured. Fruits with only 3 mature carpels were usually very regular in shape, with straight erect carpels, whereas fruits with 4 or 5 mature carpels were less regular and had the carpels usually twisted. Each infructescence held fruits which were predominantly of either the 3-carpelled or the 4 and 5-carpelled kind. However, some 1 to 6-carpelled fruits, either straight or with various degrees of twisting, could occur on any infructescence and almost all of the infructescences had fruits with examples of gradation in both the number and the twisting of the carpels.

At the Emu Creek site, most fruits also had either 3, 4 or 5 mature carpels but frequently some had 2, and less often 1 or 6. At one extreme of the morphological range within the population, some infructescences had most of their fruits of the same regular 3-carpelled kind described for the Burbang site. The remaining fruits of these infructescences were 4-carpelled or less frequently 1-, 2- or 5-carpelled, with all carpels having the same straight and erect shape. At the other extreme, one infructescence had some of its fruits with 4 mature carpels but most with either 5 or 6, the carpels of each fruit being strongly twisted with their upper portions incurved and overlapping. Other infructescences had fruits showing a range of variation between these two extremes, i.e. variation in carpel number, shape and degree of twisting. The plant bearing the twisted, 5- or 6-carpelled fruits had leaves which were a little broader and with somewhat less depth to the spongy base than those of other plants. However, both extremes had the same wide, overlapping sheaths and a cylindrical appearance in cross-section below the sheath apex.

At most sites, non-twisted fruits were generally more or less squat with short (often <2 mm long) erect stylar beaks, each beak clearly demarcated by the abrupt inward curvature of the dorsal carpel surface. In contrast, twisted fruits generally possessed more attenuated carpels with longer (3–4 mm long), commonly undemarcated, stylar beaks more or less continuous with the dorsal carpel surface. In twisted fruits the whole carpels or just the stylar beaks were often strongly and regularly incurved and overlapping so that the beaks projected quite strongly from the fruits. From herbarium collections examined, carpels appear to become longer and more attenuate as locations become more northerly into Queensland.

The rhizomes and tubers of *T. procerum* are usually quite deeply subterranean. A plant (*Aston 2828*) of the eastern variant dug from damp loam beside a swamp at Cathcart, New South Wales, had rhizomes 20–25 cm below the soil surface; tubers were obtained from 40 to 60 cm below the surface and others would obviously have occurred at greater depth, as roots were still extending deeper.

Triglochin rheophilum Aston, *Muelleria* 8: 94 (1993).

TYPE: "Victoria — East Gippsland; Pyramid Creek, c. 0.05 km north on the Combienbar road from Club Terrace, 37°32.4′S, 148°56.2′E. .... 14 Dec. 1991, *W.M. Molyneux s.n.*". HOLOTYPE: MEL 705965. ISOTYPES: BRI, CANB, MEL 705964 & spirit material, NSW.

Rhizomes horizontal to vertical, 3.5–18.5 cm long × 4–14 mm diam., bearing long fine soft fibres 2–11 cm long. Tubers globular (young one), narrow-ellipsoid or narrow-oblanceolate to elliptic or obovate, or elongated and ± long-cylindrical to narrow-rhomboid and tapered at each end (often twisted or pitted by the gravelly substrate), 11–80(–102) mm long × 2–11 mm diam. (length 1.8–12.5(–20.4) times as long as diam.), terminating roots 25–126(–178) mm long; each root 1.2–7.9 times as long as its

tuber. *Leaves* 41–450 cm long × (1–)2–16 mm wide, usually isolateral, non-glossy, semi-translucent and mid-green to reddish-green, completely submerged at or several centimetres below the water surface and often loosely spiralled or with undulate margins (leaves somewhat dorsiventral when stranded, with upper surfaces darker green and ± glossy), linear throughout whole length (including sheathed portion) except tapered distally, acute to narrow-obtuse, thin-textured, not thickened and spongy toward the base, sheathed over the lower (13–)18–42% of the leaf length. *T.S. leaf about 3 cm below the sheath summit*: linear to thinly plano-convex, width 4.4–20.7 times the thickness; each side of sheath 1.4–5.2 mm wide, equal c. 18%–40% of the leaf width but mostly inrolled so that sheath width when rolled is 1–3.2 mm, equal only c. 11%–26% of the leaf width. *Stems* in fruit (19–)29–115 cm long (including the infructescence) × 2–18 mm diam. *Rachis* 1–10 mm diam. at base, gradually tapered upwards; rachis and pedicels pale green-cream, rarely tinged maroon-cyclamen. *Infructescence* 5–36 cm long (= (8%–)20%–42% of the total stem length) × 15–30(–35) mm diam.. *Pedicels* often slender, upcurved, 2.5–9 mm long. *Fruits* touching, those on longer pedicels loosely so, those on shorter pedicels more firmly so, (20–)35–232 per rachis, 4–9 per 1 cm of rachis length, ellipsoid to mildly obovate in outline, 9–16 mm long × 5–9.5 mm diam. *Carpels* 6(or 7), in fruit usually straight and erect but sometimes partly spiralled around each

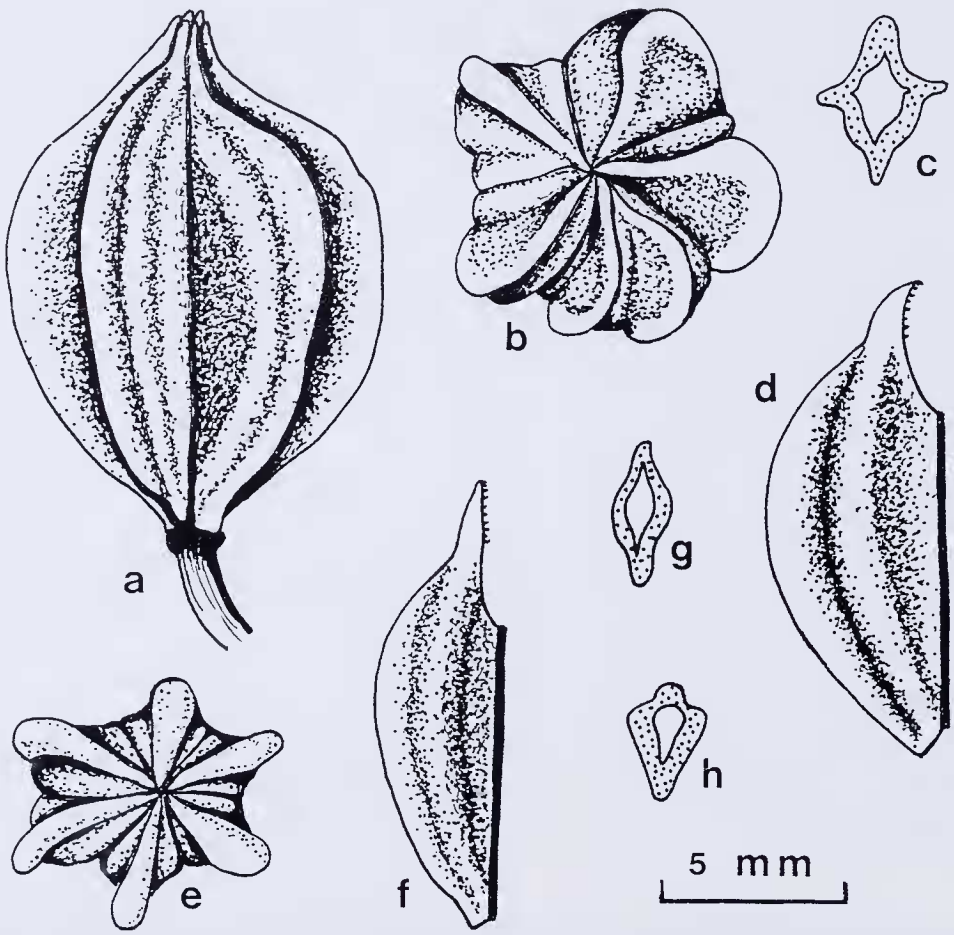

Fig. 14. Fruits and mature carpels of *Triglochin rheophilum*. Ventral attachment shown by a thickened line on carpels in lateral view. a-b — fruit, lateral and apical views. c-d — carpel, T.S. and lateral view. e — fruit, apical view. f-g — carpel, lateral view and T.S. h — carpel, T.S. (a-d — from *Clarke 1934*. e-g — from *Aston 2842*. h — from *Aston 2676*)

other and then giving a twisted appearance to the fruit, normally all maturing, 8.5–15.5 mm long × 1.6–2.8 mm wide × 2.1–4.6 mm deep; ventral edges attached along their whole length (excluding the beak sinus); attachment length = 63%–70% of carpel length; lateral faces ± flat, adpressed; dorsal ridge typically prominent and narrow-rounded, sometimes broad-rounded and less pronounced, (17%–33% of carpel depth); shoulder ridges inconspicuous before carpels separate and then seen in T.S. to be 0%–16% of carpel width (i.e., non-demarcated to projecting from the lateral faces). (Figs 2e-f, 3h-i, 14)

DISTRIBUTION (Fig. 15)

From south-eastern Queensland through eastern New South Wales and eastern Victoria to Tasmania. Mostly east and south of the Great Dividing Range.

NOTES

See Aston (1993) for fuller information on this species.

T. rheophilum is restricted to clear, often swiftly flowing, non-polluted, flood-prone streams and rivers.

DIAGNOSIS

The long (to 4.5 m), narrow, linear, thin-textured, non-spongy, leaves with narrow, usually inrolled, leaf sheaths and the fruits of *T. rheophilum* are distinctive. Mature fruits are 9–16 mm long, ellipsoid to mildly obovate in outline, and 4–9 per 1 cm of rachis length. The 6(or 7) mature carpels are attached over most of their length, each with a narrow and prominent dorsal ridge. Pedicels (to 9 mm long) are often longer and narrower than in other species.

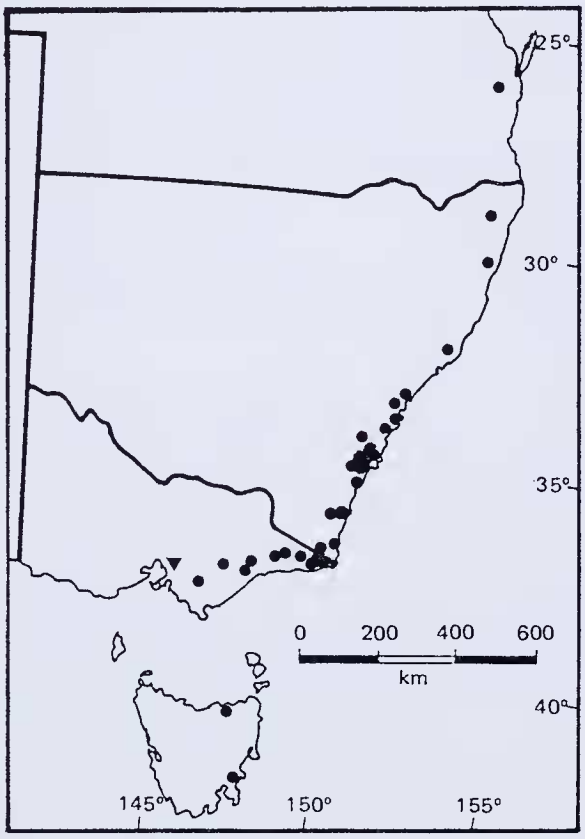

Fig. 15. Distribution of *T. rheophilum*. Triangle = a doubtful record.

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I again thank those persons acknowledged in my precursor paper of 1993. Since then D.E. Albrecht (then at MEL) and D. Cook (Melbourne), G.S. Lorimer (Montrose) and V. Stajsic (Ballarat) have located significant populations and I. Richmond (Little River) has allowed special access to his property. A.H. Marshall (near Numurkah) has particularly watched for *T. dubium* in his district. P.S. Short (MEL) obtained a photocopy of Fitzgerald's manuscript of *T. pterocarpum* while Australian Botanical Liaison Officer at Kew Herbarium. M Henwood (SYD) forwarded McDonell's unpublished thesis on loan and N. Rea facilitated access to her unpublished works. Working facilities have been available at MEL through the courtesy of J.H. Ross, and MEL staff have provided discussion and curatorial support.

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